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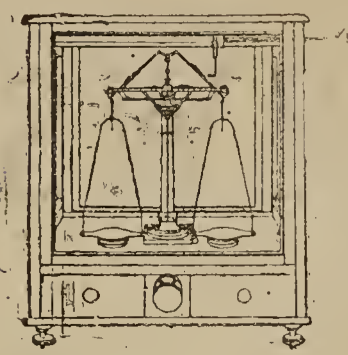

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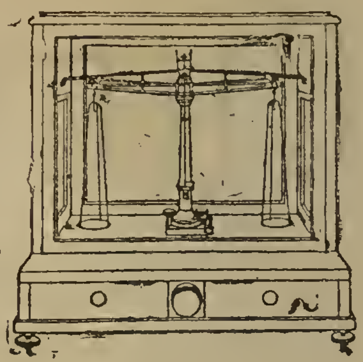

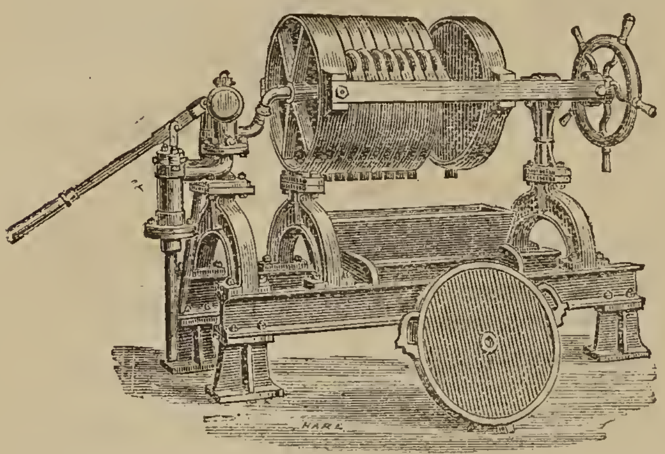

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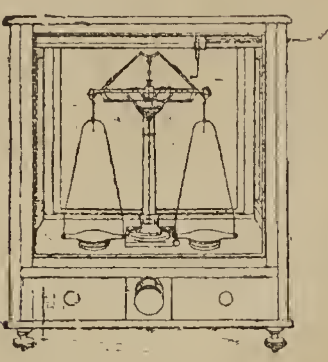

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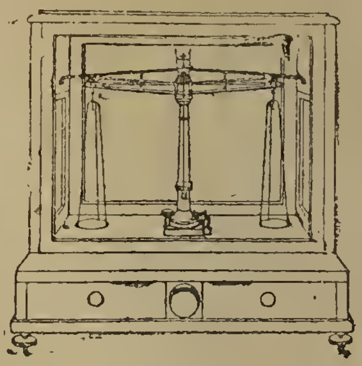

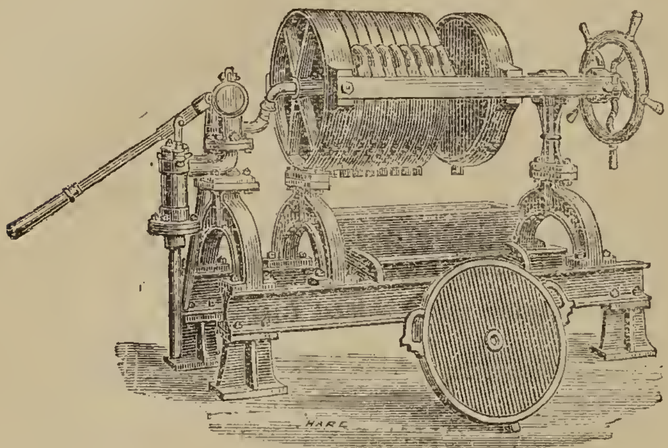

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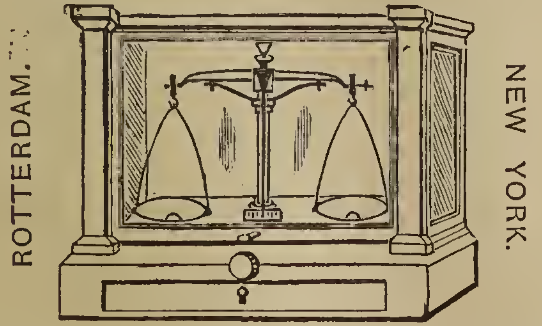

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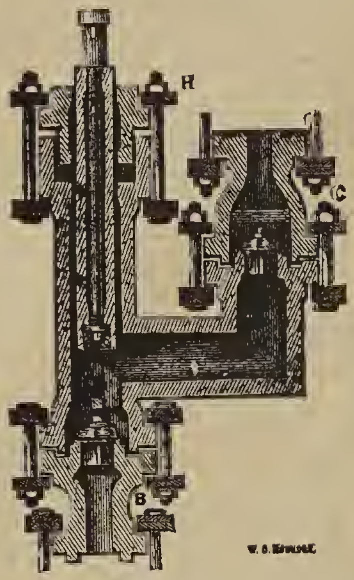

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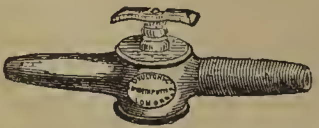

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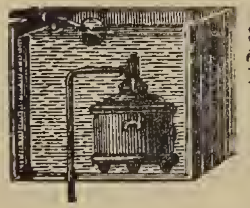

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HYDRAULIC FILTER-PRESSES.

In the CHEMICAL NEWS of 28th March last (p. 128), which, accidentally, only recently came into my hands, I find an article from Mr. J. Marzell, describing and highly recommending a pretended new construction of the Dehne Filter-press, by which an absolute extraction of the cakes deposited in the press is said to be effected in a novel and peculiar manner. This article contains so many errors and incorrect statements, which may lead to grave deceptions, that a rectification appears desirable in the common interest.

As a characteristic mark of the author's want of experience in the practical working of filter-presses in general, and particularly of presses of the especial construction he describes, I may point out that he maintains, that the so-called new arrangement for the absolute washing of the cake, and extraction of its soluble parts, prevents the air from remaining in the cake, and that in the old construction of Dehne, and in the presses of other makers, such air prevented the perfect penetration of the liquid through the cake, and that the absolute extraction obtained in the new press is principally due to the arrangements provided for the expulsion of the air. Anyone who has worked with filter-presses knows that only very few pulps which have to undergo the process of filtration in a filter-press do contain any air, and that in the way such pulps are brought into the press, by means of a Montejus, or a force-pump, no air bubbles can form in the cakes. Such air bubbles, therefore, only exist in the imagination of the author of your article.

Instead of proving the presence of air in the cakes of Dehne's old presses, and presses of other makers, as should have been done in advancing an assertion never heard of before, the existence of air is simply assumed from the necessity, for instance in the porcelain and clay industry, of further preparing the cakes delivered by the press, by clay cutting machines, before they are fit to be worked on the wheel. Up to this time porcelain manufacturers never had the slightest idea that this was done to remove the air contained in the cake, but were rather of the opinion that the subsequent preparation on the cutting and kneading machinery was necessary for obtaining and mixing a perfectly homogeneous material of sufficient plasticity. It is hardly likely that they will replace the cutting machinery by the new washing arrangements of Dehne's press, which, according to Mr. Marzell's explanations, effect the complete removal of the air, unless this new effect is proved to be something more than pure fancy.

These air bubbles—assumed to be present in the cakes of all filter-presses, but which, except in very few instances, exist in reality only in the imagination of Mr. Marzell—play, in the further explanations of the functions of the new press, and in what is represented to be perfect extraction, a contradictory and most fantastical part. Mr. Marzell infers or assumes that the air bubbles become so grouped together as to form a kind of network of small canals, through which, in the old presses, the washing liquid will find its way without washing the more compact parts of the cake.

According to Mr. Marzell's own statement the essential effect of the so-called *new* washing process of Dehne is obtained by the air being expelled at the commencement of the operation, and its space filled with the liquid. Nobody who knows anything about the laws of hydraulics will be able to understand why the bubbles presumed to be filled with air in the old presses, and grouped together so as to form a network of small canals, will offer an easier passage to the wash water, and, according to Mr. Marzell, will limit the effect of the washing to the surface of the small canals only; whereas in the new Dehne press the air being expelled out of such small canals in the beginning of the lixiviation operation, and the same being filled with liquid, they should now prevent the easier circulation of the liquid, and force it to make its way through the more compact parts of the cake, and so effect a perfect extraction of all soluble parts. According to the law of hydraulics, fluids under pressure take the way of least resistance, and after these laws the internal working should be quite the contrary to what Mr. Marzell maintains it to be. The air remaining in the canals should prevent the washing liquid from passing them, and cause it to find its way through the more compact parts, so as to effect a more perfect extraction; and in the Dehne press, always following Mr. Marzell's deductions, the small canals, after the expulsion of the air, should facilitate an easy passage of the liquid, and bring the surface of such canals only in contact with the same, rendering the extraction of soluble particles contained in the compact part of the cake impossible.

Such a deduction, which unwittingly proves the contrary of what it is meant to prove, can only be explained by a total, perhaps pardonable, want of knowledge about the laws of Nature. But less pardonable does it appear that the representative of an apparatus does not possess the most shallow knowledge of the functions of the same, as may be demonstrated by the following remarks of Mr. Marzell. In describing the subsequent ways of the washing liquid, in order to explain the superiority of the Dehne press over all others, he says that the water rises at both sides of the cake in the grooves of the press plate, that on its way it expels the air, and that it finally enters the cake from *both sides*; that by this means it has only to make half the way through the resisting cake in comparison to other presses, where, coming from *one side only*, it had to pass the whole cake; or that in Dehne's new press, taking the cake to be 1" thick, it has to make only a way of ½" against 1" in other presses. In describing the ways taken by the washing water, Mr. Marzell, after having followed it up to the middle of the cake, has only forgotten to tell us where it now remains. The water from both sides meets in the middle line of the cake under equal pressure and having no outlet, no circulation (which alone can effect the extraction of the soluble particles) can take place—always granted, of course, the process to be such as Mr. Marzell describes it.

The designer, however, of Dehne's press has had more foresight than Mr. Marzell, who, in fact, has not understood either its construction or its work. In the described Dehne press the wash water, exactly the same as in all other filter-presses, is introduced by a corner channel or tubular passage in the filtering space formed between the grooves of the press plate and the perforated metal plate to one side of the cake only; it has to penetrate the whole cake and is led away from the filtering space on the opposite side by a similar tubular passage [see Specification of Dehne's press, No. 1957, Henry Edw. Newton, May 15th, 1878, page 3, line 45, &c.:—"The object of this construction is to introduce the washing fluid by the tubular passage (in the lower projecting pieces) into the filtering space on one side of the cake, and to cause the washing fluid to penetrate the cake in order to fill up the entire filtering chamber, and to make the washing fluid to escape through the filtering space on the other side of the cake into the tubular passage in the upper projecting pieces, &c."]

There is no difference whatever between Dehne's new press and the presses of the other makers, in respect to the way in which the liquid is intended to penetrate the cake and to effect the extraction.

These explanations of Mr. Marzell's, which can hardly be taken for anything else but a mixture of misunderstandings regarding the construction of the press represented by him and its functions, and perhaps of delusive information, Mr. Marzell pleases to call the theory of the press, and he passes on to give information about the result of the filtration and extraction, by quoting results obtained in a sugar manufactory in Bohemia or Moravia, information which no doubt issues from a similarly reliable source as his knowledge about the functions of the apparatus. These results, however, may be judged by the simple fact that the liquor is called pretty *concentrated*, notwithstanding its dilution by the addition of 176 litres (39 gallons) of wash water to the filtrate of 157 kilos. (315 lbs.) of cake.

After having shown the imaginary advantage the Dehne press does *not* possess against older apparatus, and how far its working does *not* differ from that of the older apparatus, I will now in a few words dwell on the differences that really do exist, and the importance of what are supposed to be improvements.

The Dehne press has two additional so-called tubular passages arranged in the corner of the frames for the circulation of the washing liquid and the expulsion of air, instead of the one of older presses, serving in similar manner for the same purpose, viz.—

1. A second corner channel in the lower part of the frames, which communicates with, say, for instance, the 2nd, 4th, 6th, &c., frame, and with the one side of the cakes, whilst the corner channel in the upper part of, say, the 1st, 3rd, 5th, &c., frames used in the Dehne, as well as in all other presses, communicates with the opposite sides of the cakes.
2. On the same frames, containing in their lower part the above-mentioned second corner channel, he has a third channel for the escape of air arranged on the upper part of the frames, which communicates by branch passages with the same side of the cake as the said second channel.

The purpose of these two additional channels is imagined to be as follows:—Whereas in the old presses the wash liquid was introduced by the channel in the upper part of the frames from above to one side of the press cake and had to penetrate the same, and find its exit through an open cock at the other side; the fluid in the Dehne press is introduced by the corner channel in the lower part of the frame; in rising in the space provided between the grooves of the press plate and the perforated plate, it expels the air contained therein by the third channel provided at the upper part of the same frame, and after the escape of all air, the cock of the air channel being turned off, it is imagined to be driven by the applied pressure diametrically through the cake.

I shall further on dwell more fully on the probability of a uniform *penetration* of the liquid through all parts of the cake, which is the necessary condition for a quick and absolute extraction with the least quantity of water, but anyhow the water will arrive at the other side of the cake, and from there find its exit by the corner channel at the upper part of the frame.

The old presses, therefore, performed the extraction of the soluble parts of the cake exactly in the same manner as these presses of Dehne. It was proved, however, by careful examination of the wash liquid, and the extracted cakes (see *Zeitschrift des Vereins der Rübenzucker Industrie*, &c., 1864, p. 642; *Jahresbericht über die Fortschritte der Rübenzucker Fabrication*, &c., by Dr. Stammer, 4, p. 144; *Walkhoff*, *Der practische Rübenzucker-Fabricant*, IV. Edition, vol. ii,. p. 42; Dr. Stammer's *Lehrbuch der Zucker Fabrication*, pp. 444-471), that the cake is extracted on the surface only, the particles contained in the liquid, and apparently taken up from the cake, are in reality washed from the filter-cloths, the interior surfaces of the press plates, of the frames and corner channels, and but very little was taken up from the surface of the cake. The apparent extraction was shown therefore to be of no practical advantage, as the quantity of soluble matter taken up from the surface of the cakes was of too little importance to compensate for the disadvantage of the greater dilution of the filtrate, and the washing of the cloths, and the interior parts of the machine is no gain, as at the next charge they will again be soaked by filtered liquor.

The failure of the process of extraction in all these presses is explained by the fact that the cake being held in a flabby and elastic cloth, the wash liquid finds easier passages through which to arrive to the exit side of the cake, than by going diametrically through the same. It will avoid, therefore, the great resistance of the cake itself, and naturally choose the easier penetration round its corners and edges, and thereby only wash the surface of the cake, and (very unnecessarily) also the filter cloths, press plates, frames, &c. The manner of forming the cake within the press, and supporting it, being exactly the same in Dehne's press as in all the old ones, there is no reason why in Dehne's press the liquid should choose to go through the compact cake, avoiding the easier passage round the corner and edges.

But another question arises; that is, whether the new so-called "improvements" of Dehne might not perhaps be capable of effecting a real extraction by other means than by the uniform penetration of the liquid through the cake. And this, in fact, appears to be not at all improbable. The liquid passing round the corner and edges soon surrounds the whole cake, and by continuous supply and outflow, an uninterrupted circulation is kept up during the whole time of the operation. In this way an interchange of the soluble filtrate in the cake, and a more or less perfect extraction, is gradually effected by means of a process of diffusion. Such process of diffusion being, however, as is generally known, an exceedingly slow chemical process, it is natural that the time for obtaining a really absolute extraction is long and varies very much, proportionately to the nature and composition, thickness and density, of the cake. It is at any rate much longer than the extraction will take in an apparatus which, by its peculiar construction, guarantees with absolute certainty a uniform penetration of the liquid through the cake. Also the wash liquid obtained by diffusion, as explained, is necessarily very much diluted. These circumstances greatly reduce the practical value of the so-called improved arrangements of Dehne, and render them illusory for most purposes.

Besides these imperfections of the improved Dehne press, it possesses, together with most other presses, the great disadvantage arising from the use of filter cloths. The first cost of such cloths, together with the cost of preparing the filters and the changes, which are generally far more frequent than Mr. Marzell asserts them to be, amounts as a rule, in a German sugar manufactory in one "campagne" of about 120 working days, to the cost of a new press. Many pulps are, if capable at all, at least very difficult of filtration in a filter-press with cloths. The use of cloths, and also the light construction of the presses now generally adopted, only permits very slight pressure; indeed, hardly more than 30 pounds on the square inch. The cakes, in consequence, possess but little consistency, and contain far more filtrate than if they had been thoroughly pressed out, and as for the washing operation, they naturally also require a larger quantity of wash liquid. A further very serious disadvantage of filterpresses with cloths—a disadvantage more specially felt in chemical works—is that the cloths get damaged if employed for the filtration of pulps containing acids or alkalies; so much so, in fact, that they become too expensive to permit certain operations and processes to be carried out by means of such filter-presses.

The Press invented by me and patented in Great Britain a considerable time before Dehne filed his patent, does away with these drawbacks (see specification No. 850, 2nd March, 1877). The filtration and the extraction is effected through solid indestructible filter-media and in a far more perfect way than in Dehne's press. Dehne's so-called improved arrangement for the absolute extraction of the soluble parts of the cake, in so far as it consists in the application of two additional corner channels, constitutes in fact an infringement upon my patent for a press without cloths, which provides in its claims for similar arrangements for the introduction and exit of the liquid, *and all purchasers and users of the Dehne press will therefore make themselves liable to legal prosecution.*

It is too long to give here a detailed description of this new filter-press without cloths. It has, however, lately been introduced into Great Britain, and

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(Signed) Dr. DREVERMANN.

Berlin, *June*, 1879.

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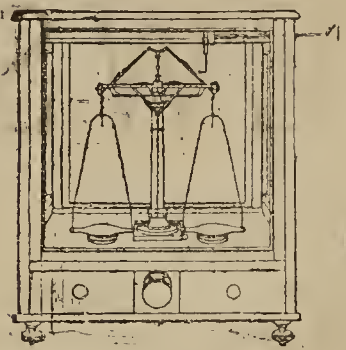

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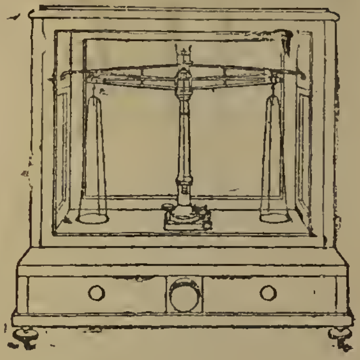

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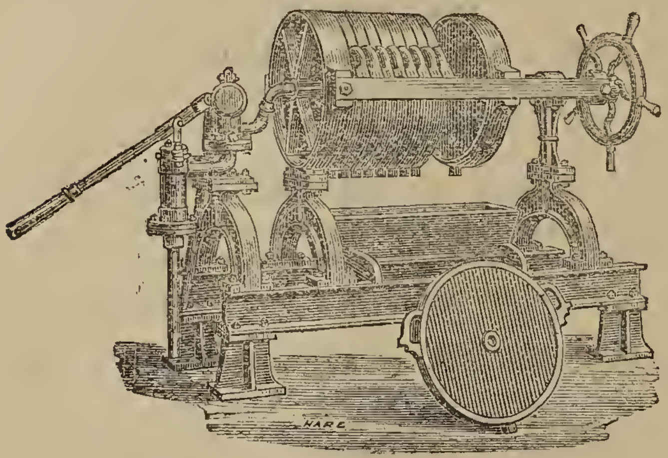

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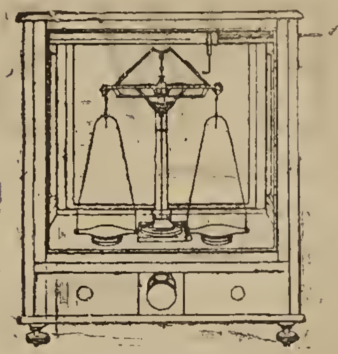

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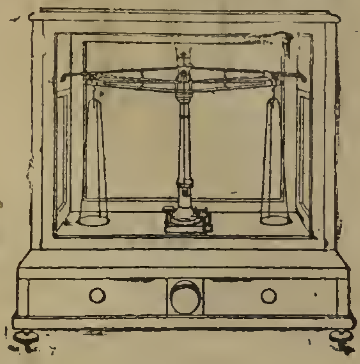

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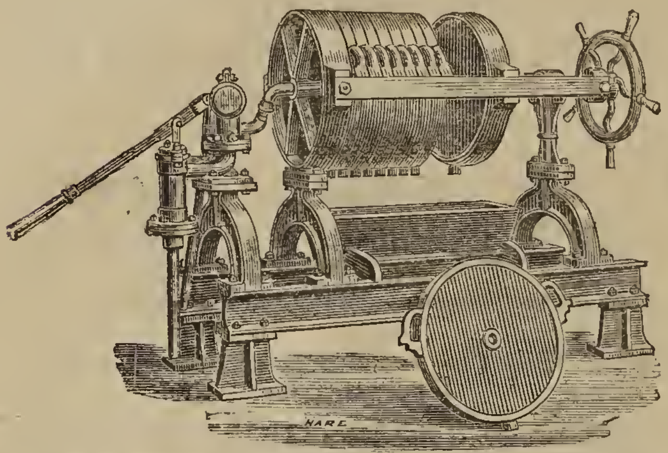

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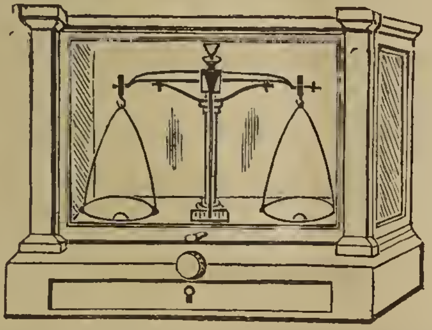

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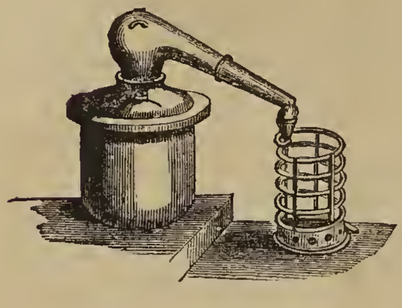

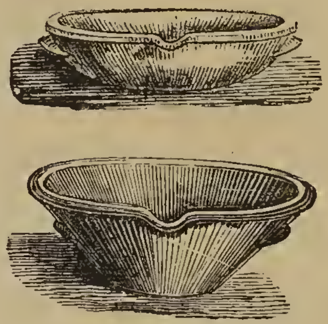

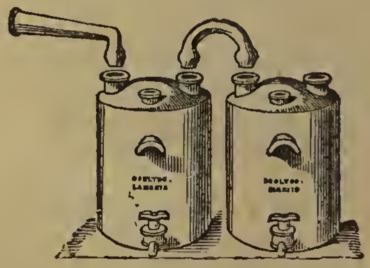

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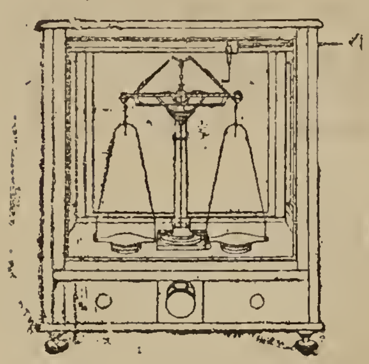

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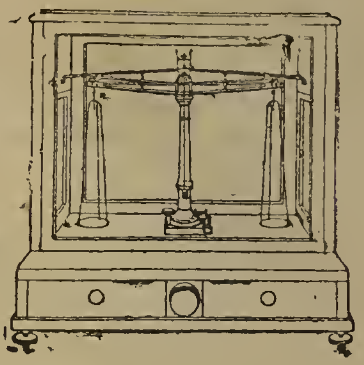

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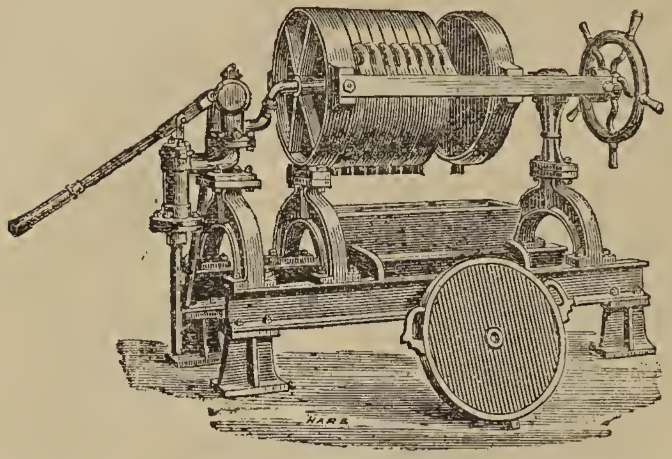

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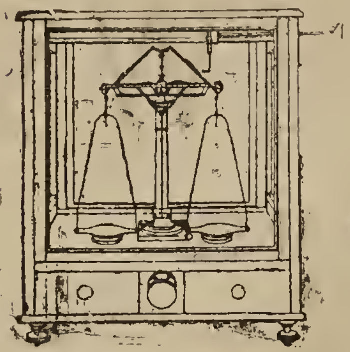

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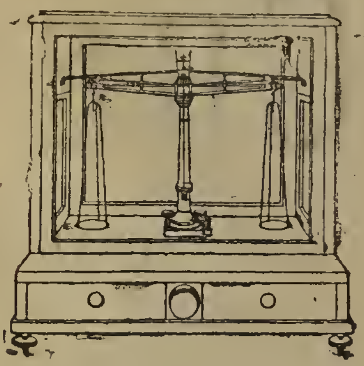

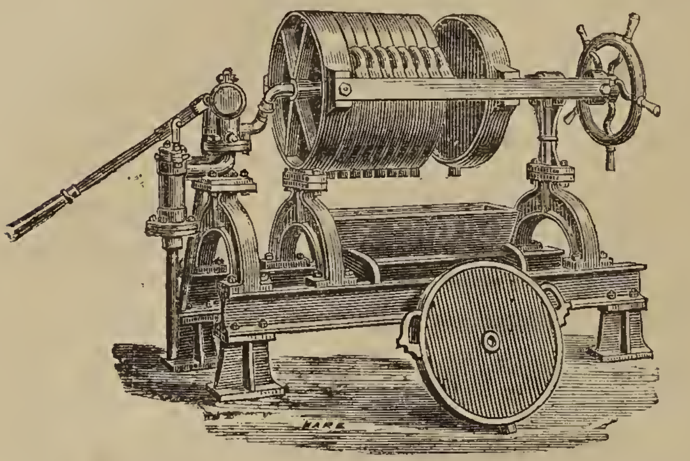

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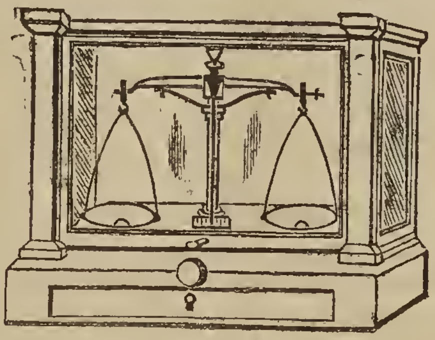

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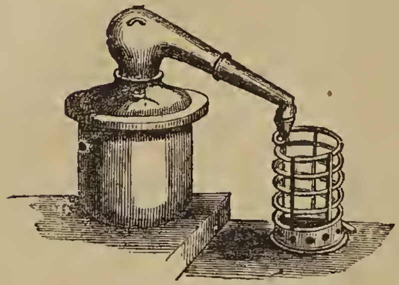

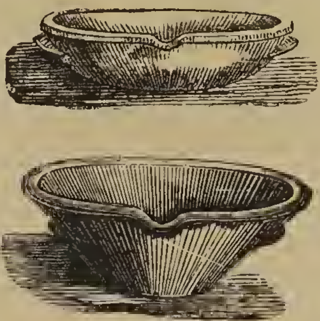

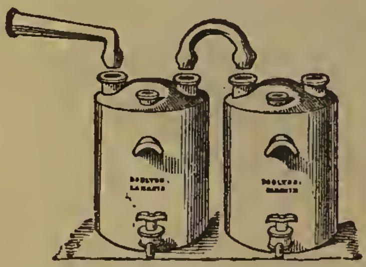

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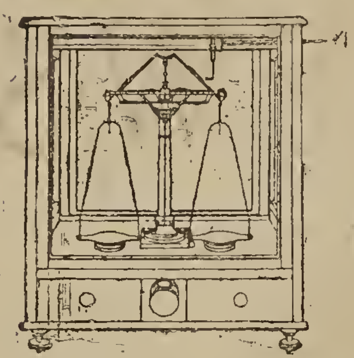

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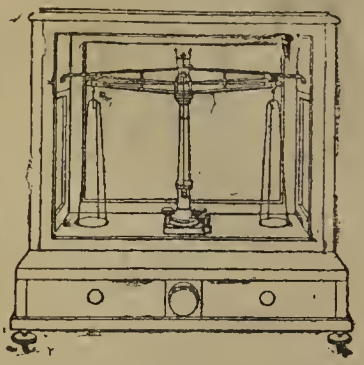

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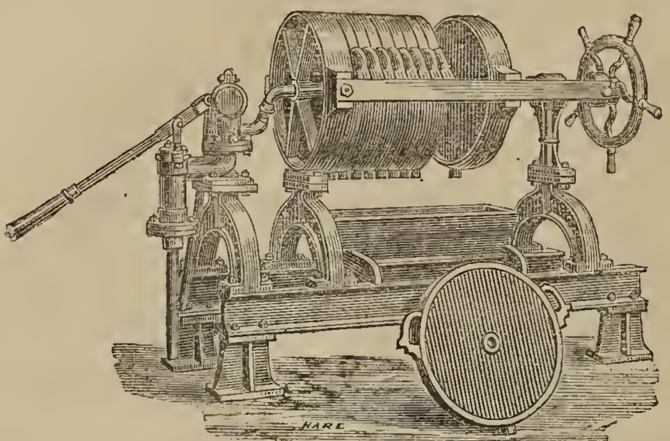

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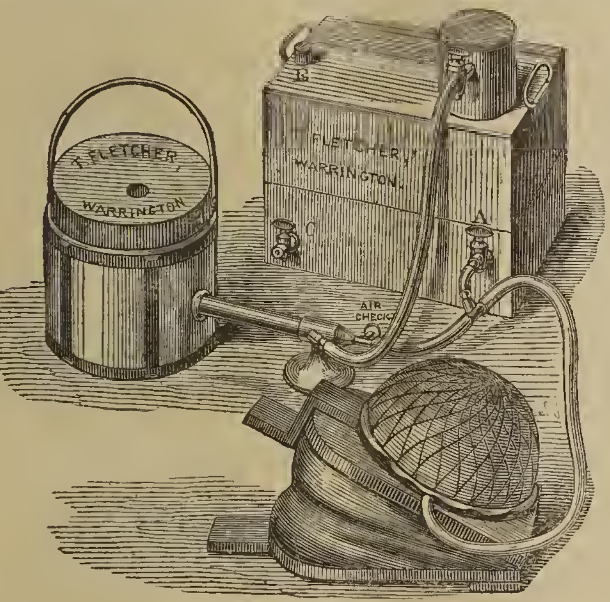

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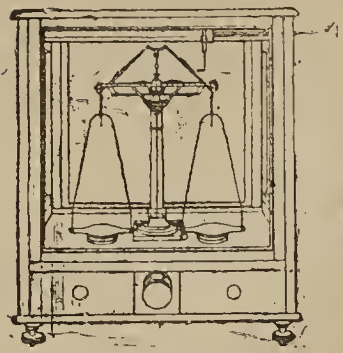

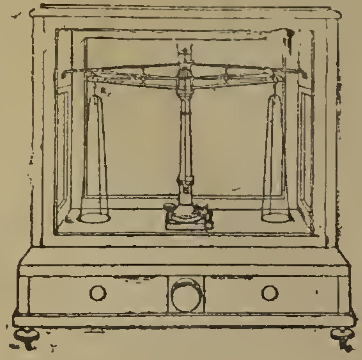

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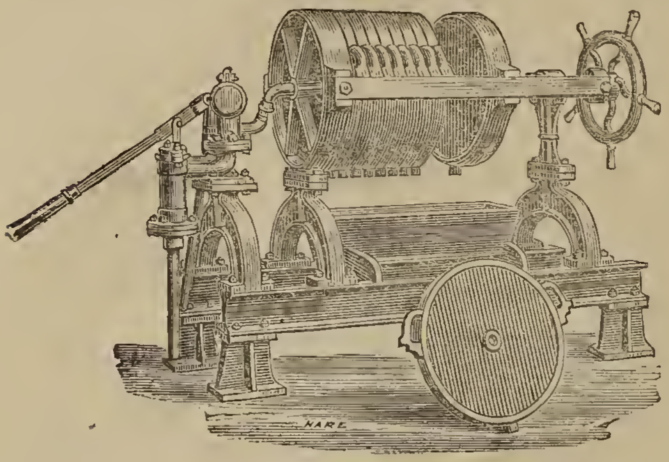

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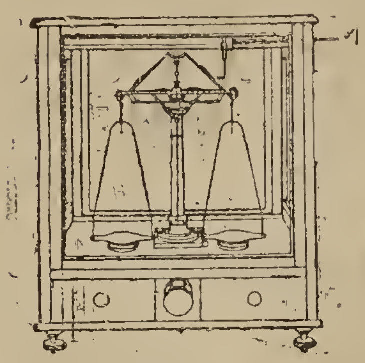

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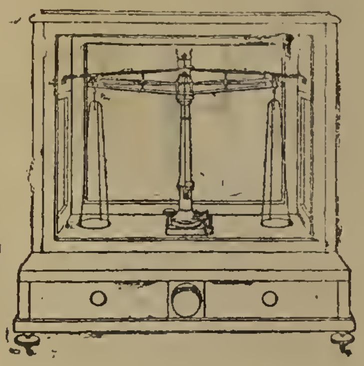

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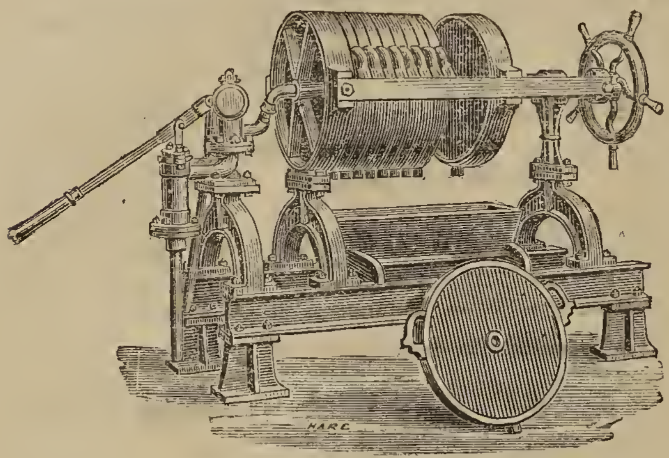

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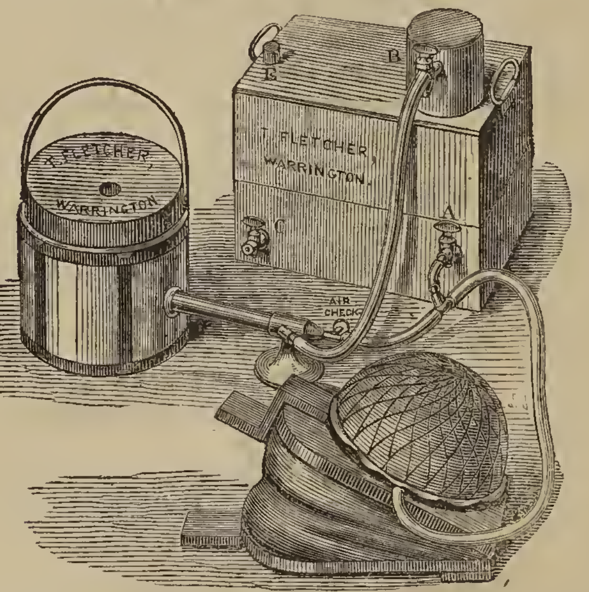

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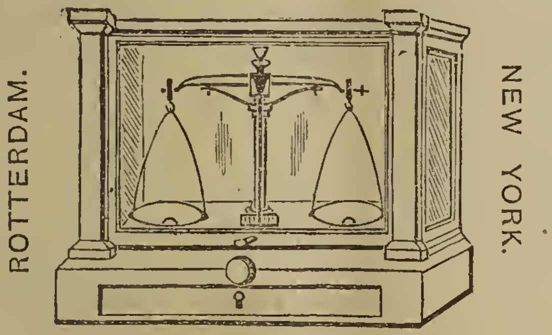

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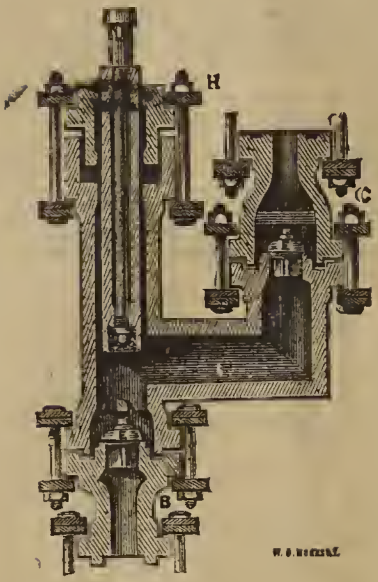

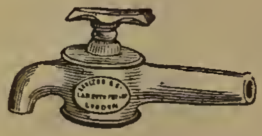

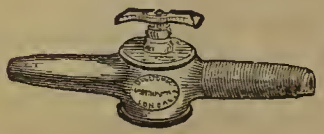

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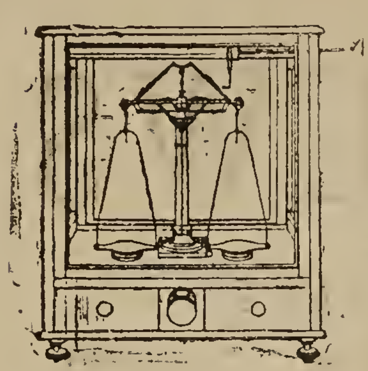

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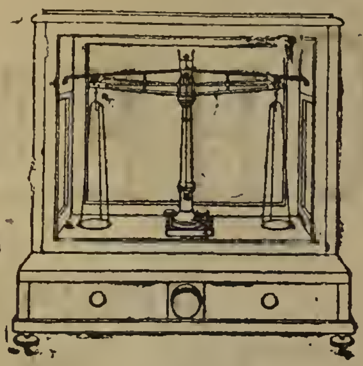

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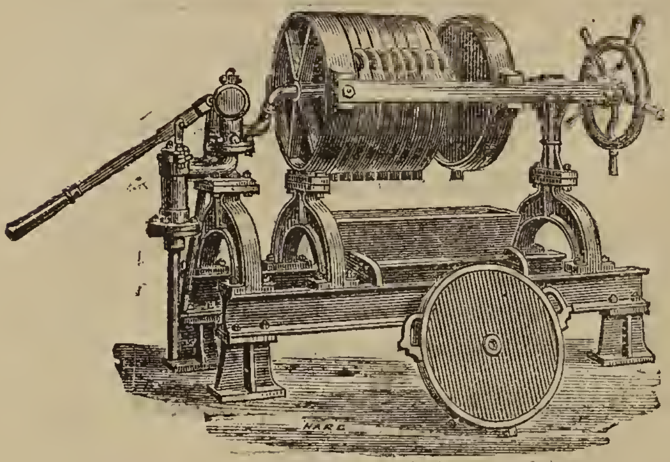

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and
In the matter of the Court of Chancery of Lancaster Acts 1850 and 1854,
and
In the matter of BOUCK and CO., Limited.

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(1.) A plot of land fronting the Rochdale Canal and Varley Street, containing 5191 square yards or thereabouts, and held for the residue of a term of 99 years from the 18th April, 1853, subject to two yearly chief rents of £62 and £14 0s. 8d., and to the covenants, conditions, and agreements affecting the same.

(2.) A plot of land fronting the Rochdale Canal and Vickers Street, containing 1096 square yards or thereabouts, and held for the residue of a term of 99 years from the 30th December, 1850, subject to two yearly chief rents of £6 17s. 0d. and £29 13s. 8d., and to the covenants, conditions, and agreements affecting the same.

(3.) A plot of land fronting Vickers Street, Varley Street, and the Rochdale Canal, containing 3560 square yards or thereabouts, and held for the residue of a term of 999 years from the 18th July, 1862, subject to two yearly rents of £59 6s. 8d. and £59 6s. 8d., and to the covenants, conditions, and agresments affecting the same.

(4.) A plot of land fronting James Street and Vickers Street, containing 2096 square yards or thereabouts, and held for the residue of a term of 99 years from the 8th June, 1857 (except the last ten days thereof), subject to a yearly chief rent of £52 8s. 4d., and to the covenants, conditions, and agreements affecting the same.

The Buildings, Boilers, Plant, and Stock at these works consist of the following, namely:—

TAR DEPARTMENT.

Two brick covered wells capable of holding respectively 3500 tons and 100 tons of tar or thereabouts, with 3 ram pumps, suction and delivery pipes from the wells to the stills, 18 wrought-iron tar stills capable of distilling 400 tons of tar or thereabouts per week, 6 wrought-iron 8-tons anthracene stills with Cameron pump for removing products attached (which stills respectively have condensers, receivers, and connection pipes to the wells), 10 elevated wrought-iron storage tanks capable of holding 80 to 90,000 gallons of crude products or thereabouts, with taps and delivery pipes. A large iron pitch shed with corrugated iron roof, and a brick built pitch house capable of cooling 300 tons of pitch or thereabouts per week. One brick built anthracene shed containing cooling and storage tanks; 4 filter-presses; 2 hydraulic presses, with pumps and fittings, together with 4-inch Cameron pump for pumping anthracene oils, with piping and fittings attached; 2 brick creosote wells capable of holding respectively 170,000 gallons and 1000 gallons or thereabouts, with ram pump, suction and delivery pipes; 9 naphtha rectifying stills, total capacity of 10,200 gallons or thereabouts, with small vertical engine; 4 ram pumps for charging these stills, together with condensers, receivers, and fittings; 2 wrought-iron horizontal reception agitators, total capacity 3000 gallons or thereabouts, with small vertical engine and driving gear attached; 3 wrought-iron storage tanks capable of holding 4000 gallons of rectified naphthas or thereabouts; Carbolic Acid Plant, comprising two cisterns for agitation (capacity 1000 gallons each or thereabouts), with neutralising tank; 2 Cameron ram pumps with suction and delivery pipes and fittings; 4 ram pumps, and a vertical engine with pumps attached for lifting water for condensing purposes, with suction and delivery pipes, taps, and fittings; one 12-inch Cameron pump for discharging tar and liquor from the canal boats, with pipes, taps, and fittings.

SULPHURIC ACID DEPARTMENT.

One sulphuric acid chamber, with brimstone furnaces and coke towers, capable of producing 8 tons of acid or thereabouts per day, with one boiling-down pan. Sulphate of ammonia plant, with horizontal boiler and tower, capable of working 120 tons of liquor or thereabouts per week; two wrought-iron liquor ammonia stills, total capacity 8 tons or thereabouts, with ram pump, purifiers, condensers, and receivers.

SULPHATE OF *ZINC* DEPARTMENT.

A number of lead-lined neutralising tanks with cooling tanks, capable of producing 5 tons or thereabouts per week.

FLOUR SULPHUR DEPARTMENT.

4 cast-iron pots with brick chambers and connections, capable of producing 2 tons of flour of sulphur or thereabouts per week.

NITRIC ACID DEPARTMENT.

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STOCKS AT THESE WORKS.

(Raw Materials and Products

Nitre Cake
Carbolic Acid
Litharge
Nitrate Lead
Flour Sulphur
Sulphate Copper
Sulphate Ammonia
Sundry Drysalteries
Brown Vitriol
Anthracene
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Copper Precipitate
Rectified Benzole
Naphthas
Packages
Pitch
Nitrate Soda
Tar
Ammonia Water
Crude Naphtha

SECOND.—AS TO THE BLACKBURN WORKS.

A plot of land at Further Gate, in Blackburn, fronting Forrest Street and adjoining the Leeds and Liverpool Canal, containing 4070 superficial square yards or thereabouts, and held for the residue of a term of 21 years from the 1st of October, 1869, subject to a yearly rent of £42 7s. 11d., and to the covenants, conditions, and agreements affecting the same.

The buildings and plant at these works consist of the following:—

A range of brick built sheds, including office, store room, naphtha rectifying house, and a range of brick built sheds covering sulphate of ammonia plant and anthracene filtering room.

One square brick chimney about 30 yards high.

One brick built Anthracene oil well capable of holding 200 tons or thereabouts, with suction and delivery pipes attached.

Three brick built anthracene oil wells, two uncovered and one covered, total capacity 10,000 gallons or thereabouts, with suction and delivery pipes attached to each.

One brick built creosote well (covered) capable of holding 76,000 gallons or thereabouts, with delivery and suction pipes.

Two wrought iron tar stills capable of working tons of tar or thereabouts per week, with wrought iron condenser, tanks, worms, and receivers to each, together with connecting pipes to well.

One damaged cast-iron still capable of holding 18 tons or thereabouts with worm condenser, tank, and connections.

Two wrought-iron ammonia stills, total capacity 20 tons or thereabouts, with nozzles, agitators, delivery and discharging pipes, together with lead-lined fishing-box, drainer, and 2 lead-lined sulphuric acid tanks.

One naphtha rectifying still, capable of working 1200 gallons or thereabouts, with lead worm condenser.

Four wrought-iron storage tanks, total capacity 9500 gallons or thereabouts, with delivery and discharge pipes.

Anthracene plant, with hydraulic press, range of filter bags, and wooden troughs, together with delivery pipe connections.

Platform weighing machine.

One two-flued steam boiler, of about 20 nominal horse-power, with mountings, and steam connections through yard.

One vertical engine, working by shaft and eccentrics, 2 small water rams, and 3 ram pumps for tar and liquor, with taps, pipes, and connections to stills and store tanks.

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STORES AT THESE WORKS.

(Raw Materials and Products.)

Tar, anthracene oil, pitch, ammonia water, sulphate of ammonia, anthracene, crude naphtha, and light oil.

The purchaser will be required to take all such quantities of the stocks and stores, both at the Newton Heath and Blackburn Works, as may be ascertained, to be on the Company's works respectively on the date fixed for the completion of the purchase at certain prices, of which a schedule can be seen at the offices of the Official Liquidator on any day prior to the 19th of September, 1879

The purchaser will also be required to take over and complete the various buying and selling contracts respectively which have been entered into by or on behalf of or with the Company, and which are still partially unperformed.

Copies of these contracts, together with an estimate of the extent to which they have been severally performed, may be seen at the offices of the Official Liquidator on any day prior to the said 19th of September, 1879.

Sealed tenders endorsed "Tender for Bouck and Company's Property (Limited)," and addressed to Mr. Ebenezer Adamson, 25, Booth Street, Manchester, will be received at his office up to 12 at noon, on Friday, the 19th day of September, 1879. The Vendor does not bind himself to accept the highest or any tender.

Cards to view, copies of the contracts, and a print of the particulars, conditions of sale, and form of tender, with any other information can be obtained at the offices of the District Registrar, Cross Street Chambers, 78, Cross Street, Manchester; of the Official Liquidator, Mr. Ebenezer Adamson, 25, Booth Street, Manchester; or,

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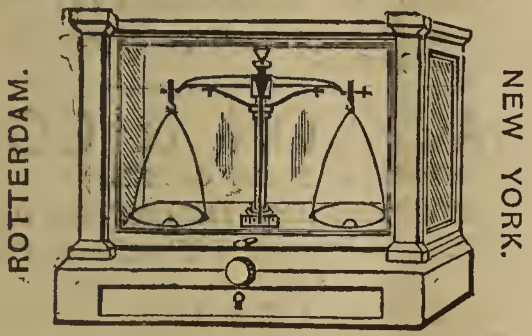

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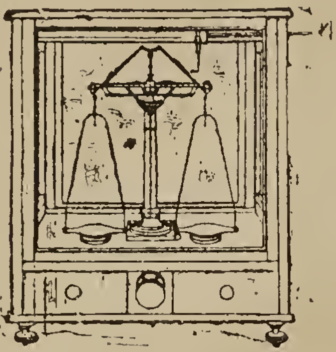

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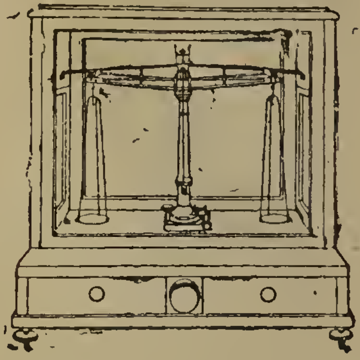

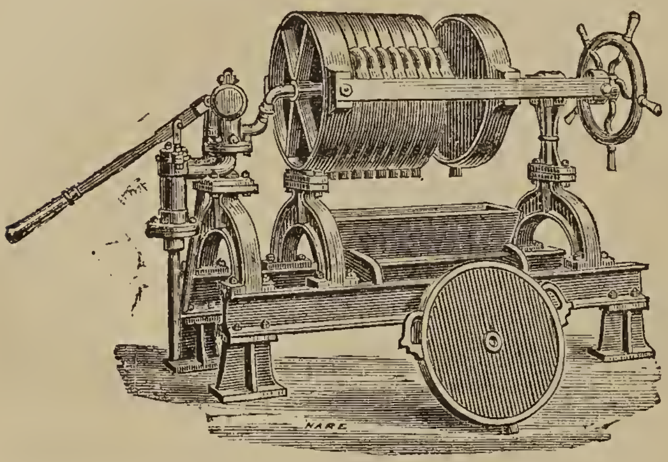

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Two brick covered wells capable of holding respectively 3500 tons and 100 tons of tar or thereabouts, with 3 ram pumps, suction and delivery pipes from the wells to the stills, 18 wrought-iron tar stills capable of distilling 400 tons of tar or thereabouts per week, 6 wrought-iron 8-tons anthracene stills with Cameron pump for removing products attached (which stills respectively have condensers, receivers, and connection pipes to the wells), 10 elevated wrought-iron storage tanks capable of holding 80 to 90,000 gallons of crude products or thereabouts, with taps and delivery pipes. A large iron pitch shed with corrugated iron roof, and a brick built pitch house capable of cooling 300 tons of pitch or thereabouts per week. One brick built anthracene shed containing cooling and storage tanks; 4 filter-presses; 2 hydraulic presses, with pumps and fittings, together with 4-inch Cameron pump for pumping anthracene oils, with piping and fittings attached; 2 brick creosote wells capable of holding respectively, 170,000 gallons and 1000 gallons or thereabouts, with ram pump, suction and delivery pipes; 9 naphtha rectifying stills, total capacity of 10,200 gallons or thereabouts, with small vertical engine; 4 ram pumps for charging these stills, together with condensers, receivers, and fittings; 2 wrought-iron horizontal reception agitators, total capacity 3000 gallons or thereabouts, with small vertical engine and driving gear attached; 3 wrought-iron storage tanks capable of holding 4000 gallons of rectified naphthas or thereabouts; Carbolic Acid Plant, comprising two cisterns for agitation (capacity 1000 gallons each or thereabouts), with neutralising tank; 2 Cameron ram pumps with suction and delivery pipes and fittings; 4 ram pumps, and a vertical engine with pumps attached for lifting water for condensing purposes, with suction and delivery pipes, taps, and fittings; one 12-inch Cameron pump for discharging tar and liquor from the canal boats. with pipes, taps, and fittings.

SULPHURIC ACID DEPARTMENT.

One sulphuric acid chamber, with brimstone furnaces and coke towers, capable of producing 8 tons of acid or thereabouts per day, with one boiling-down pan. Sulphate of ammonia plant, with horizontal boiler and tower, capable of working 120 tons of liquor or thereabouts per week; two wrought-iron liquor ammonia stills, total capacity 8 tons or thereabouts, with ram pump, purifiers, condensers, and receivers.

SULPHATE OF ZINC DEPARTMENT.

A number of lead-lined neutralising tanks with cooling tanks, capable of producing 5 tons or thereabouts per week.

FLOUR SULPHUR DEPARTMENT.

4 cast-iron pots with brick chambers and connections, capable of producing 2 tons of flour of sulphur or thereabouts per week.

NITRIC ACID DEPARTMENT.

6 cast-iron nitric acid cylinders, 72 jars and connections.

NITRATE OF LEAD DEPARTMENT.

2 stone mixers, 32 crystallising stones, 16 earthenware evaporating mugs complete.

BOILERS, &c.

3 horizontal 2-flued Galloway tube steam boilers of the following dimensions, viz.:—One of 7 feet diameter by 26 feet length, one of feet diameter by 28 feet length, and the remaining one 7 feet diameter by 24 feet length; one small horizontal 2-fluid steam-boiler, diameter 7 feet by 14 feet length (all which boilers have 4, 5, and 6 cast-iron flange pipe connections running through the works); 7 canal boats; 2 cart-horses and gearing; 3 bon carts; 3 lurries, boilers, bogie, and float; 36 tar barrels; wheelwright and joiner's shop; smithy, with anvil and blacksmith's tools; one laboratory; two offices, and small office and store-room in pitch yard; watchman's house; one cart-weighing machine, with fittings and lodge; 6 platform weighing machines; one round brick chimney 65 yards high, 80 feet feathered.

STOCKS AT THESE WORKS.

(Raw Materials and Products

Nitre Cake
Carbolic Acid
Litharge
Nitrate Lead
Flour Sulphur
Sulphate Copper
Sulphate Ammonia
Sundry Drysalterics
Brown Vitriol
Anthracene
Anthracene Oils
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Copper Precipitate
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Pitch
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The buildings and plant at these works consist of the following:—

A range of brick built sheds, including office, store room, naphtha rectifying house, and a range of brick built sheds covering sulphate of ammonia plant and anthracene filtering room.

One square brick chimney about 30 yards high.

One brick built Anthracene oil well capable of holding 200 tons or thereabouts, with suction and delivery pipes attached.

Three brick built anthracene oil wells, two uncovered and one covered, total capacity 10,000 gallons or thereabouts, with suction and delivery pipes attached to each.

One brick built creosote well (covered) capable of holding 76,000 gallons or thereabouts, with delivery and suction pipes.

Two wrought iron tar stills capable of working tons of tar or thereabouts per week, with wrought iron condenser, tanks, worms, and receivers to each, together with connecting pipes to well.

One damaged cast-iron still capable of holding 18 tons or thereabouts with worm condenser, tank, and connections.

Two wrought-iron ammonia stills, total capacity 20 tons or thereabouts, with nozzles, agitators, delivery and discharging pipes, together with lead-lined fishing-box, drainer, and 2 lead-lined sulphuric acid tanks.

One naphtha rectifying still, capable of working 1200 gallons or thereabouts, with lead worm condenser.

Four wrought-iron storage tanks, total capacity 9500 gallons or thereabouts, with delivery and discharge pipes.

Anthracene plant, with hydraulic press, range of filter bags, and wooden troughs, together with delivery pipe connections.

Platform weighing machine.

One two-flued steam boiler, of about 20 nominal horse-power, with mountings, and steam connections through yard.

One vertical engine, working by shaft and eccentrics, 2 small water rams, and 3 ram pumps for tar and liquor, with taps, pipes, and connections to stills and store tanks.

One 4-inch Cameron pump for water, with fittings.

Two wrought-iron pitch coolers, one 33 feet long × 5 feet wide × 3 feet 6 inches deep, and one 57 feet long × 5 feet wide × 3 feet 6 inches deep.

Pitch bay lined with flags, capable of holding 30 tons of pitch or thereabouts, 7 tar barrels, 1 lurry, 2 carts, 2 railway waggons.

STORES AT THESE WORKS.

(Raw Materials and Products.)

Tar, anthracene oil, pitch, ammonia water, sulphate of ammonia, anthracene, crude naphtha, and light oil.

The purchaser will be required to take all such quantities of the stocks and stores, both at the Newton Heath and Blackburn Works, as may be ascertained, to be on the Company's works respectively on the date fixed for the completion of the purchase at certain prices, of which a schedule can be seen at the offices of the Official Liquidator on any day prior to the 19th of September, 1879

The purchaser will also be required to take over and complete the various buying and selling contracts respectively which have been entered into by or on behalf of or with the Company, and which are still partially unperformed.

Copies of these contracts, together with an estimate of the extent to which they have been severally performed, may be seen at the offices of the Official Liquidator on any day prior to the said 19th of September, 1879.

Sealed tenders endorsed "Tender for Bouck and Company's Property (Limited)," and addressed to Mr. Ebenezer Adamson, 25, Booth Street, Manchester, will be received at his office up to 12 at noon, on Friday, the 19th day of September, 1879. The Vendor does not bind himself to accept the highest or any tender.

Cards to view, copies of the contracts, and a print of the particulars, conditions of sale, and form of tender, with any other information can be obtained at the offices of the District Registrar, Cross Street Chambers, 78, Cross Street, Manchester; of the Official Liquidator, Mr. EBENEZER ADAMSON, 25, Booth Street, Manchester; or,

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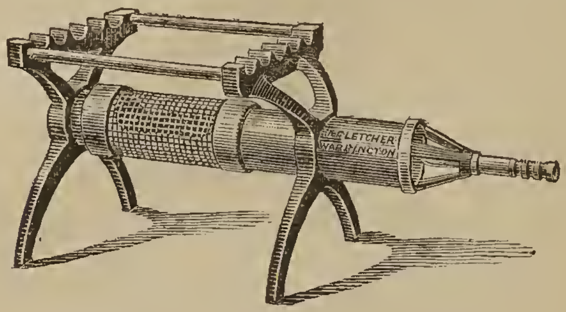

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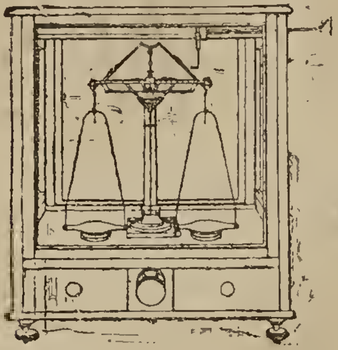

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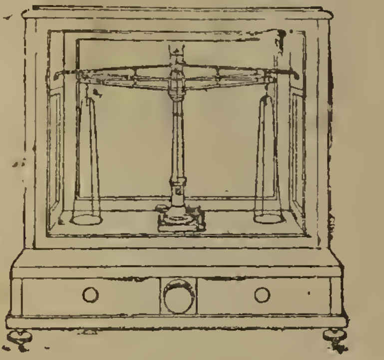

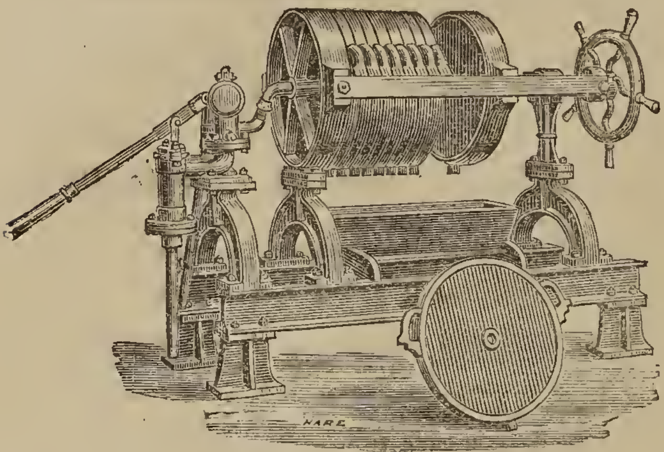

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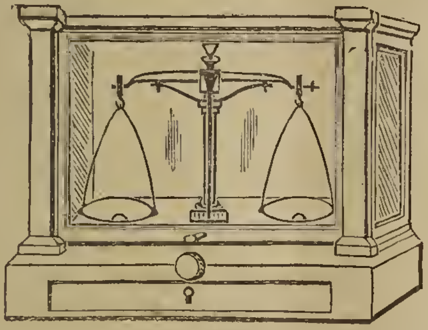

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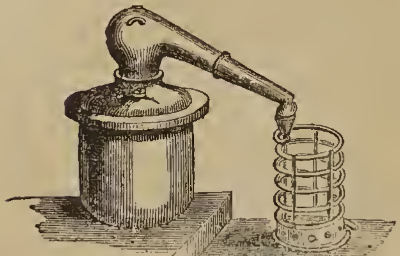

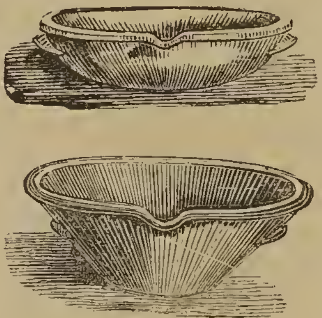

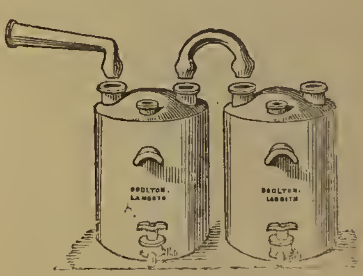

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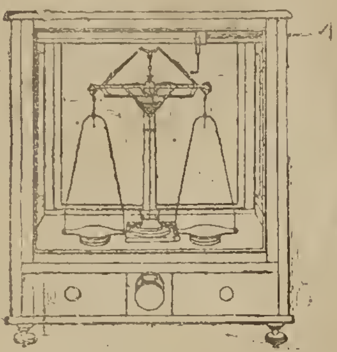

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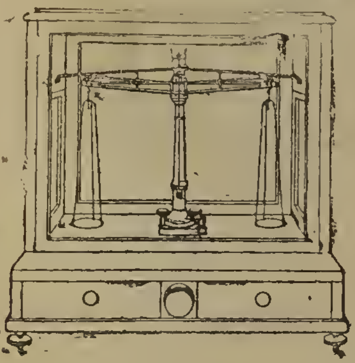

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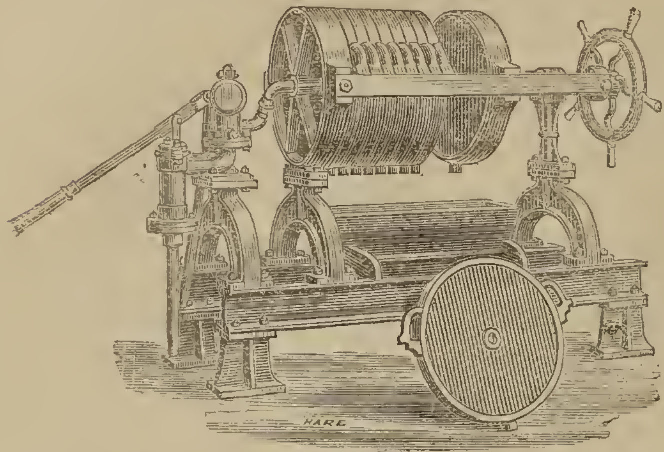

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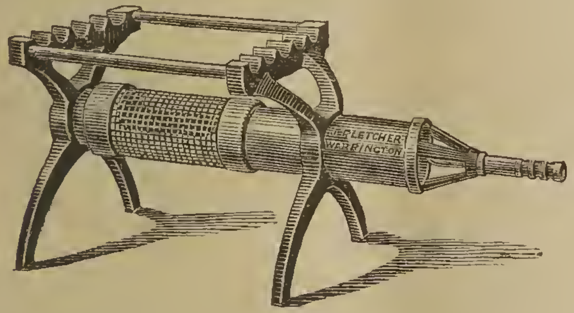

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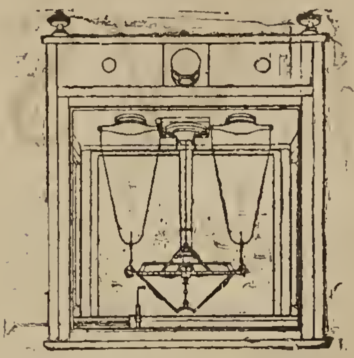

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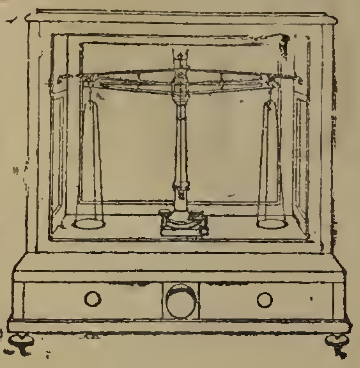

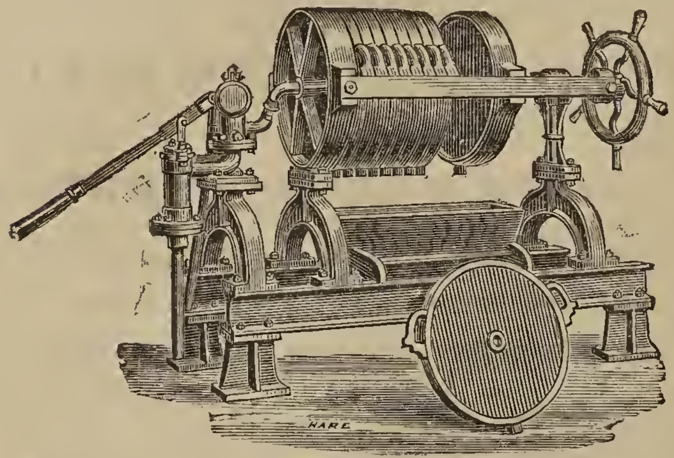

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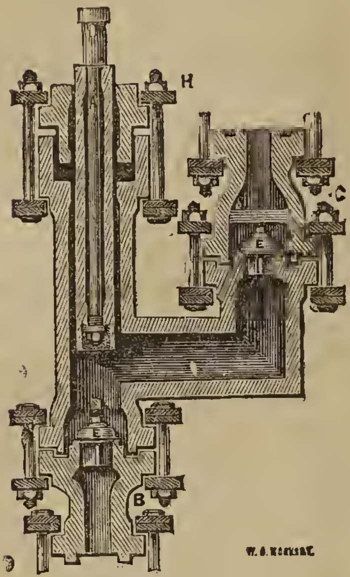

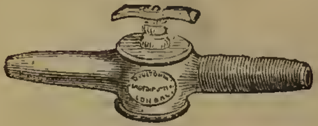

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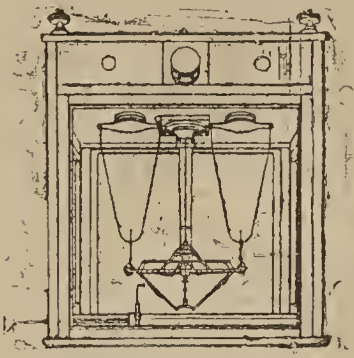

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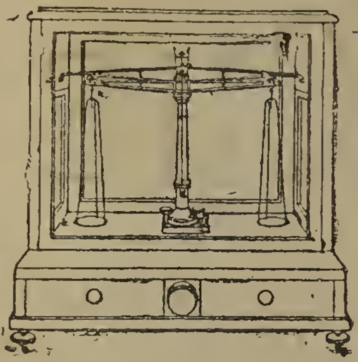

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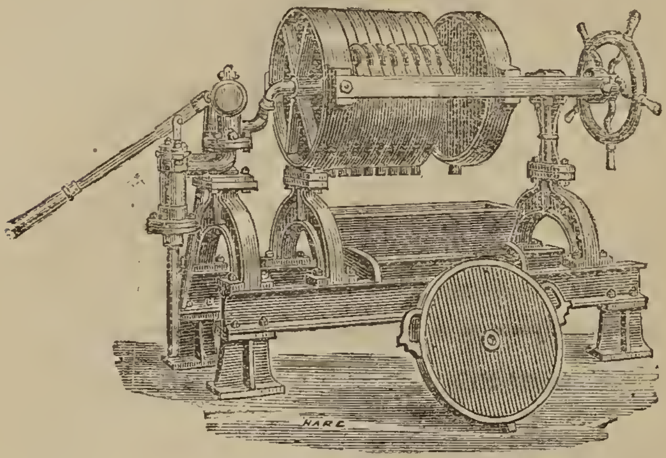

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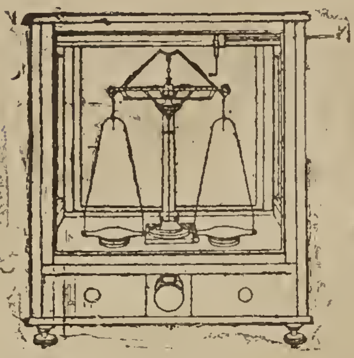

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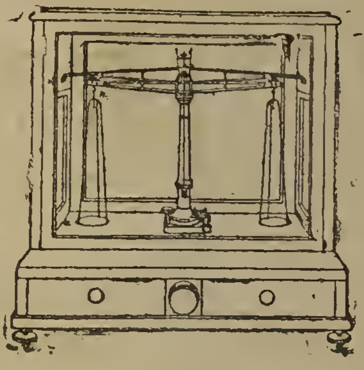

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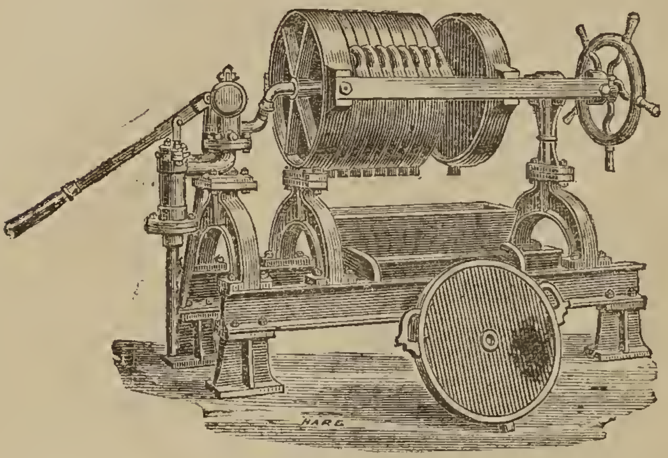

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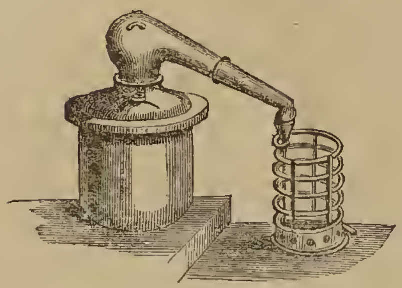

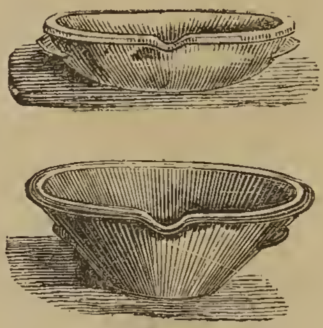

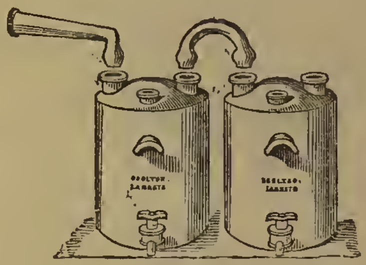

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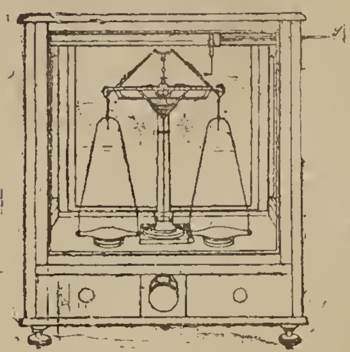

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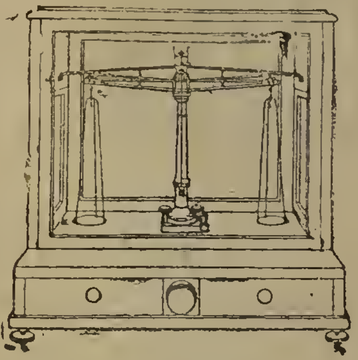

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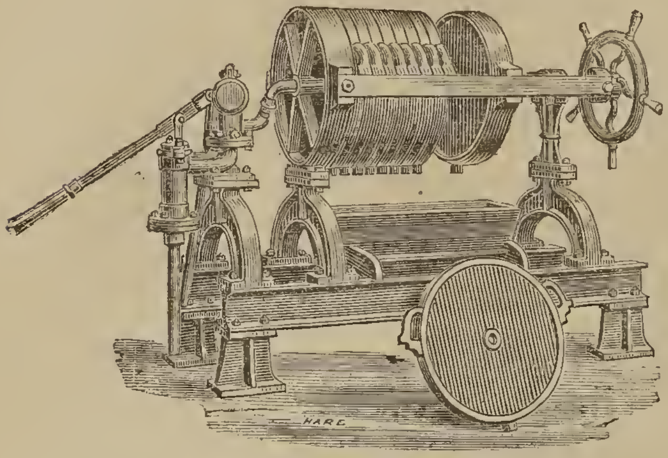

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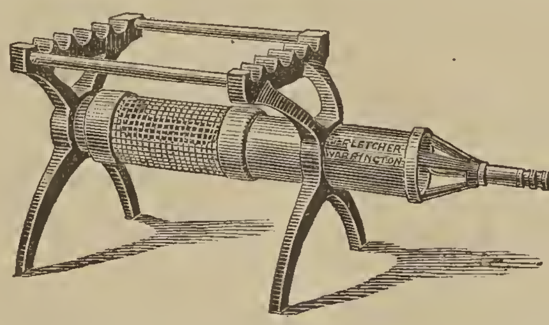

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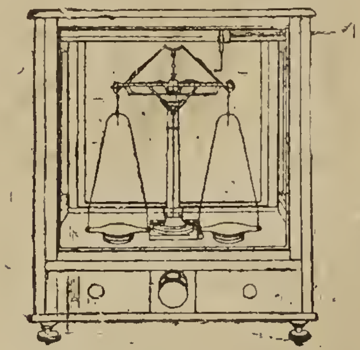

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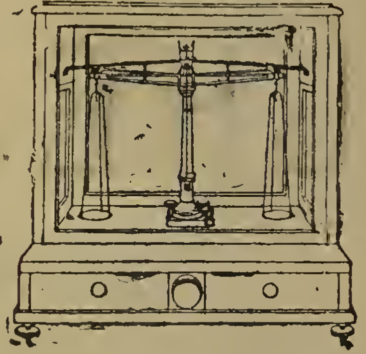

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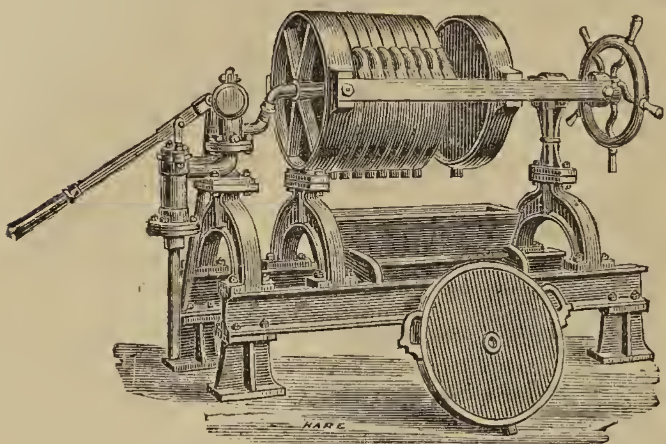

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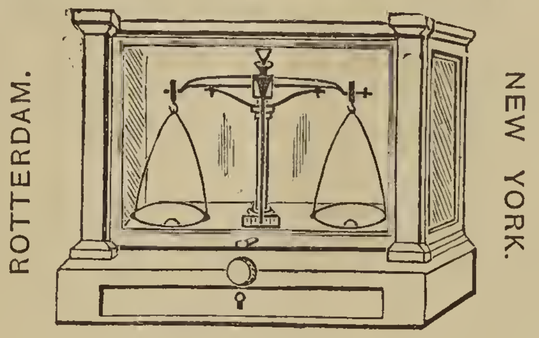

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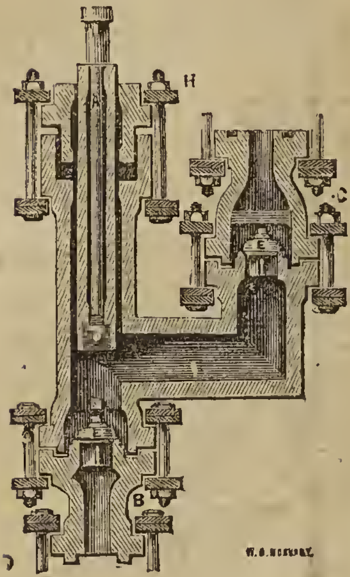

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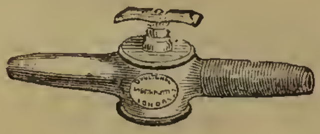

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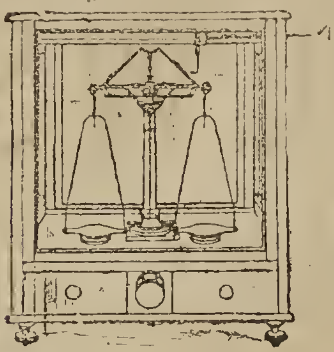

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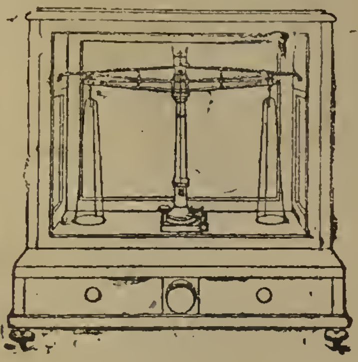

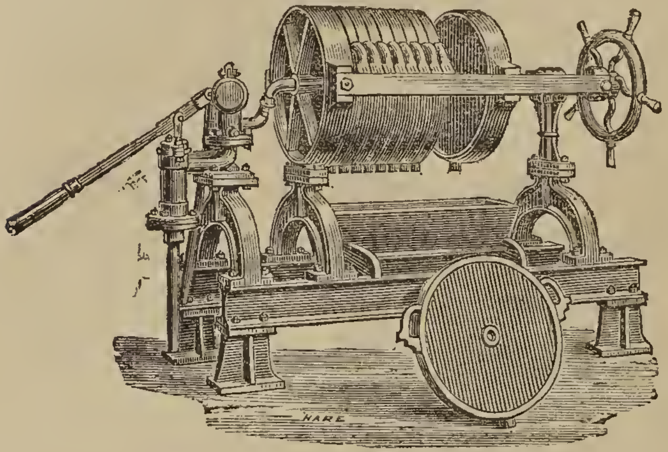

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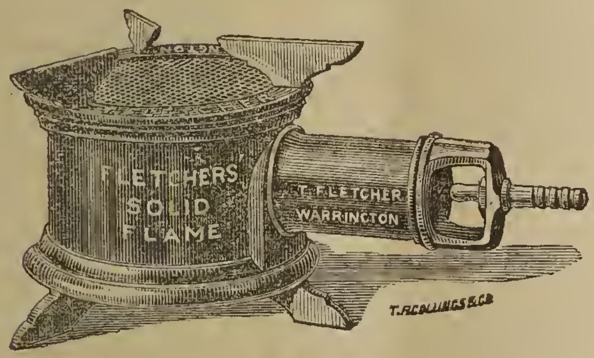

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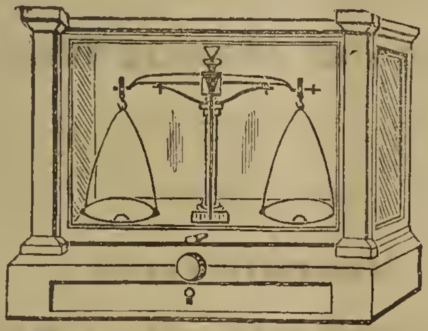

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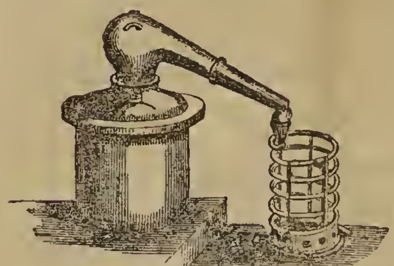

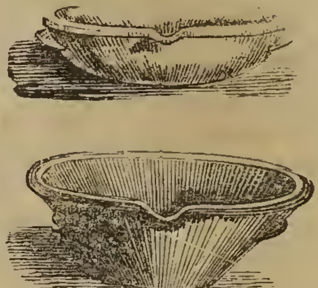

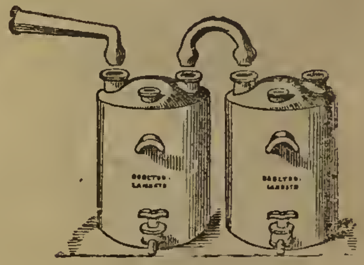

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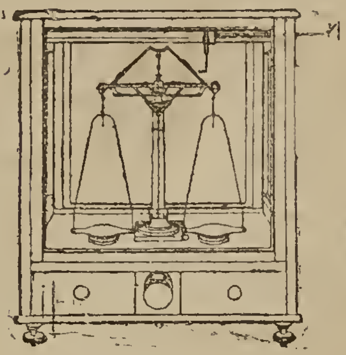

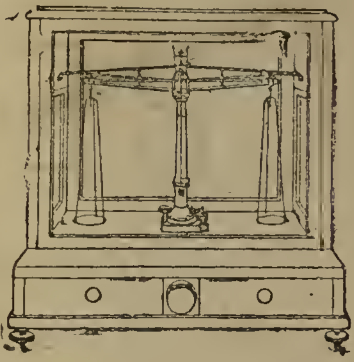

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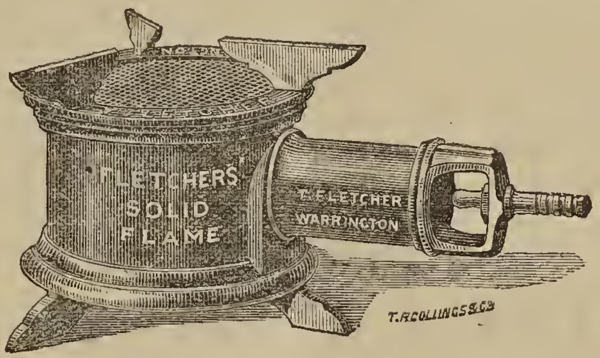

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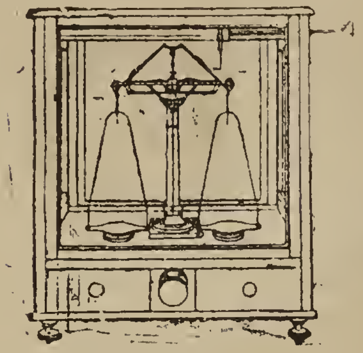

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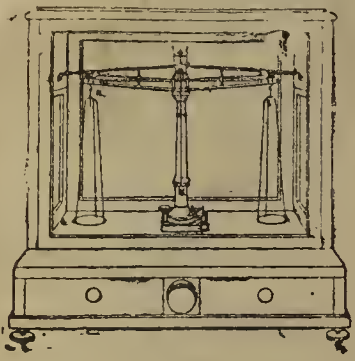

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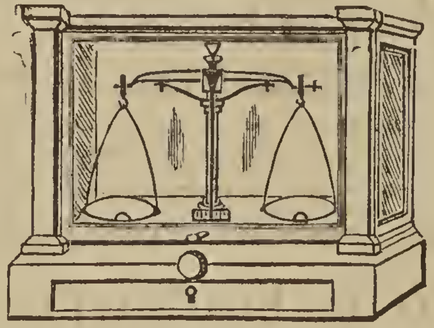

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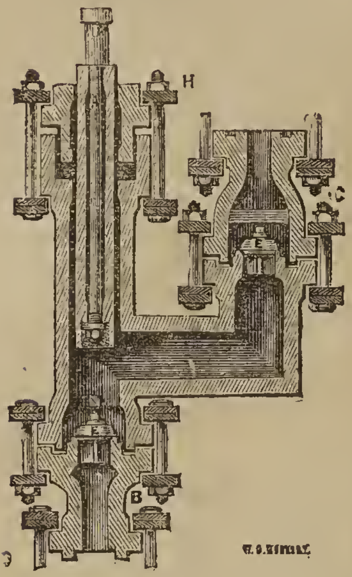

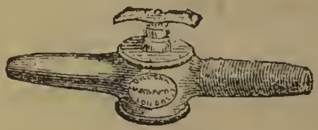

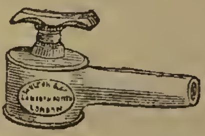

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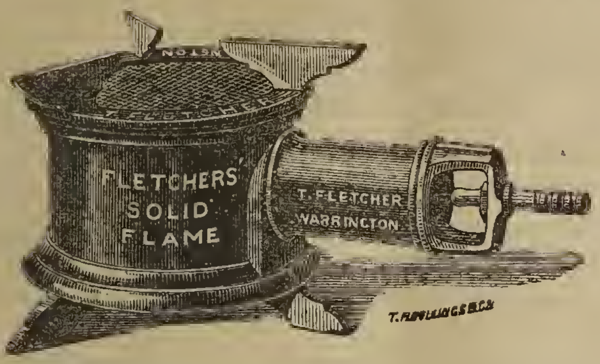

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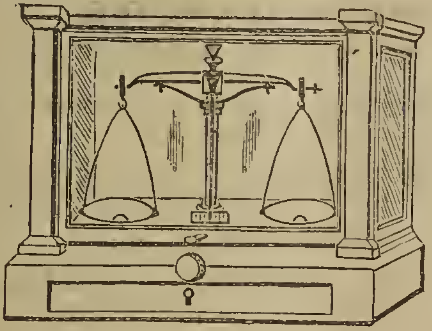

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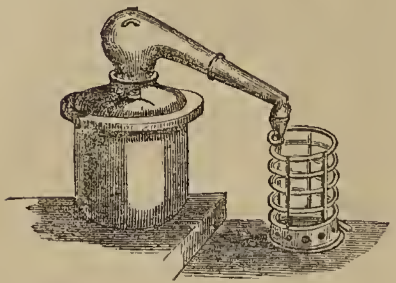

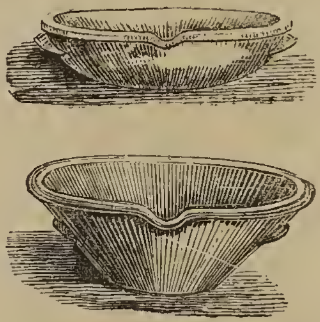

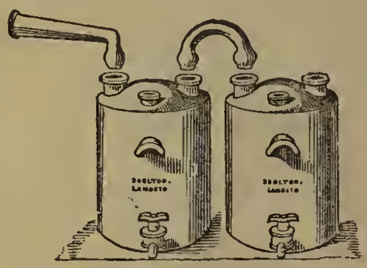

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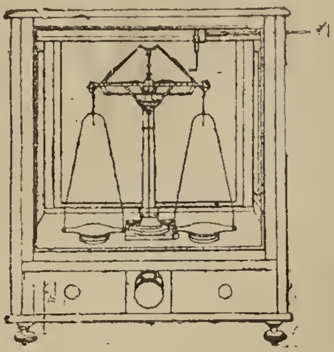

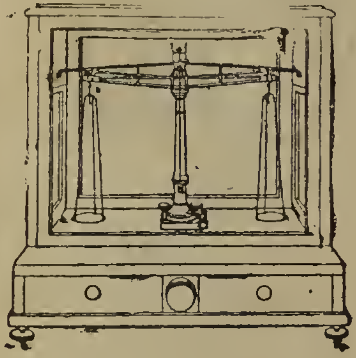

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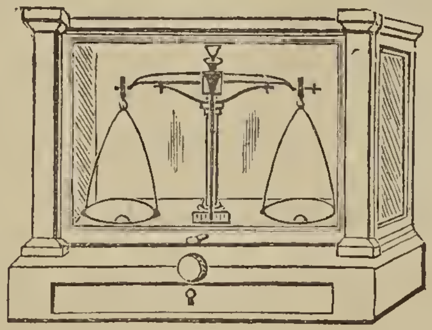

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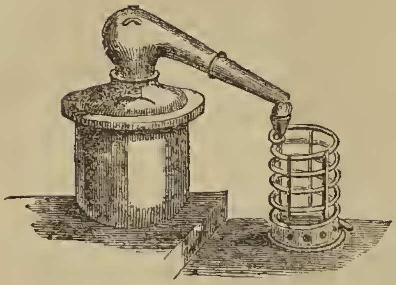

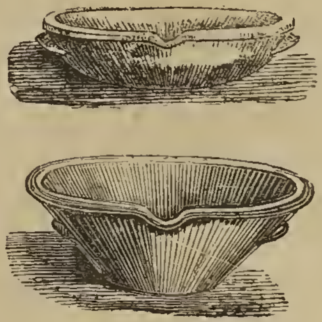

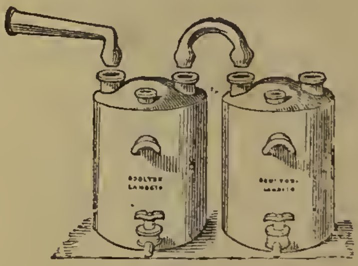

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THE CHEMICAL NEWS.

VOLUME XL.

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No. 1023.—JULY 4, 1879.

NOTES ON SOME ANALYSES OF WATERS.

By Dr. T. L. PHIPSON, F.C.S. Lond.,
Member of the Chemical Society of Paris, and of the Royal Society of Med. and Nat. Sciences of Brussels.

The following notes of some analyses made by me during the last few years may prove interesting at a time like the present, when this particular subject is attracting so much attention. As I have stated in my letter in the Chemical News (vol. xxxix., p. 63), the first question to be solved by the analytical chemist is whether the water submitted to him is fit to drink or not; and a very long experience in this class of investigations is requisite to enable him to pronounce with any degree of certainty upon this important point. In the next place it is required to know whether the water will attack and dissolve lead; whether it will corrode iron pipes or boiler-plates, and so prove injurious to those who use it. Finally, a whole host of considerations crop up as to its fitness for household and manufacturing purposes, into which there is no need to enter here.

Much stress has of late years been laid upon the *organic matter* contained in waters, and it is well to bear in mind that although a large amount, such as 6 to 8 grains per gallon, for instance, may be looked upon with suspicion, certain waters that contain as much as this may be drunk with impunity, whilst others that contain considerably less are known to be exceedingly injurious, if not fatal.

The *crenate of ammonia*, to which I alluded as being present in many spring waters (Chem. News, vol. xxxix., p. 62), and is taken up by alcohol from the dried residue, does not appear to be at all hurtful when present to the extent of as much as 4 or 5 grains per gallon; whilst putrid organic matter, numerous *bacteria* and *micrococcus*, and minute *white* fungoid growths, are sources of imminent danger.

But without further general remarks I shall content myself on this occasion by giving the following results, which, incomplete as they are, appear to me to possess a certain amount of interest, and may give some idea of the great variety of waters which, in the course of a comparatively short space of time, come under the notice of the analytical chemist:—

I. *Well near Sleaford* (*Lincolnshire*).

Water not quite clear, with an *alkaline reaction* and decidedly *saline taste*, well aërated; contains some minute *green* algæ; gases dissolved are air and carbonic acid only.

Total residue, 169 grains per gallon imp.

Chloride of sodium	76·0 grs.
Carbonate of soda	44·0 ,,
Sulphate of soda	35·0 ,,
Sulphate of potash	2·0 ,,
Chloride of magnesium	1·5 ,,
Organic matter	2·0 ,,
Phosphoric acid and bromine	faint traces
Silica	1·0 grs.
Ferric oxide	0·5 ,,
Carbonate of lime	7·0 ,,
	169 grs.

II. *St. Anne's Well, Buxton* (*Derbyshire*).

Total residue, 20 grains per gallon.

Mineral matters	18 grs.
Organic matter	2 ,,

The mineral matter consists *chiefly* of carbonate of lime and chloride of sodium, with a little sulphate of lime, traces of iron and silica; in the spectroscope traces of cæsium and strontium, no lithium or rubidium; the *residue* has a saline taste. Beautifully clear and tasteless; gives off carbonic acid on boiling, and a slight deposit of carbonate of lime. This water is said to have a constant temperature of 80° to 82° F. I found the specific gravity at 60° F. in my laboratory in London 1·003. The fact that this water cures the gout is owing probably to its great purity, to its being drunk warm and in large quantities, and to the diet, country air, and exercise prescribed to the patients.

III. *Well on Wimbledon Common* (*Surrey*).

Total residue, 32 grains per gallon.

Mineral matter	26 grs.
Organic matter and nitric acid	6 ,,

Mineral matter *principally* carbonate and sulphate of lime, with a very much smaller amount of alkaline salts. Well aërated. *No Phosphoric Acid.* A single drop of a very dilute solution of permanganate gives a rose tint to 200 c.c., which persisted for several hours. This is an example of a good well-water which has been used for drinking for many years.

IV. *Well in the Lower Bagshot Sand near Esher* (*Surrey*).

This well is 40 feet deep, and is situated about 40 feet from a small cemetery. The water is beautifully bright, clear, and odourless. It attacks lead easily, and dissolves it. It shows decided indications of nitrates and much chlorides.

Total residue, 58·8 grains per gallon.

Nitric acid and organic matter	7·0 grs.
Chloride of sodium	14·0 ,,
Sulphate, carbonates, &c.	37·8 ,,

A very deceitful water. Certainly impregnated, and likely to get worse. Sp. gr. = 1·0032. A spring much further from the little cemetery gave—

Total residue, 24 grains per gallon.

Nitric acid and organic matter	3 grs.
Mineral matter	21 ,,

This water also dissolved lead readily.

V. *A Yellow Water; Locality Unknown* (S. *of England*.)

This water was sent to me because it was supposed to be ferruginous and that it might have valuable medical properties. The locality was not mentioned. Seen in bulk, is golden yellow; quite transparent; has no sediment; when boiled, remains clear, but gives off a strong *marshy odour*.

Total residue, $2\frac{1}{10}$ grains per gallon,

Consisting almost entirely of *ulmate of lime* and *ulmate of ammonia*, with a little carbonate of lime and traces of chlorides, &c. Animal charcoal takes out the yellow colour. This water bleaches permanganate solution rapidly and in large quantities.

VI. *Well at the Midland Bank, Birmingham.*

Many well-waters in the town of Birmingham are said to attack iron, pumps, boiler-plates, &c.; this is supposed to be in virtue of the nitrates they contain, and "to be due to galvanic action."

Total residue, 81·62 grains per gallon.

Dry mineral matter after calcination .. 58·71 grs.

Contains a *very large* amount of *nitrates* and *ammonia*.

A bad water, quite unfit for household use, and said to be destructive to metal work. It would require special experiments to decide upon the nature of the action by which such a water corrodes metals, and these have not been made.

VII. *Well in an Artificial Manure Manufactory, near Southampton.*

Total residue, 3320 grains per gallon.

Free sulphuric acid	1500 grs.
Phosphates and sulphates of lime, alkaline salts, &c...	1820 ,,

This water had been used for some time, both for drinking—occasionally for making tea—and for replenishing a small boiler, until its taste became very acid, and it was then sent to me for analysis.

VIII. *Well at the Albany Barracks, London.*

Total residue, 80 grains per gallon.

Organic matter and nitric acid	8 grs.
Mineral matters	72 ,,

Supposed to have caused an outbreak of typhoïd (no details).

IX. *Well near Huntington.*

Water used for drinking. It was sought to ascertain whether it would be apt to produce calculus.

Total residue, 82 grains per gallon.

Sulphate of lime	36·89 grs.
Carbonate of lime	15·37 ,,
Chloride of sodium	16·00 ,,
Organic matter and nitric acid	5·00 ,,
Silica, magnesia, oxide of iron, &c...	8·74 ,,

Could not be proved unwholesome; would not *produce* calculus, but might prove prejudicial to the cure of that disease.

X. *Water from a Scullery Pump in Bolton Street, Piccadilly, W.*

Total residue, 1024 grains per gallon.

Half-a-pint evaporated gave a drachm of yellow liquid, closely resembling urine in all its characters. Said to have been "used for drinking, and to have produced sickness and diarrhœa." By addition of ammonia this water gave a precipitate in which was found *abundance of phosphoric acid*.

XI. *Wells at Putney, S.W.*

The *total residue* varies from 38 to 120 grains, and even more; some, which yield from 38 to 48 grains, with 7 or 8 grains of organic matter and nitric acid, have been used for drinking for many years without any apparent inconvenience. Others, that yield over 60 grains of *total* residue, containing more than 10 grains of organic matter and nitric acid, are proscribed by the medical authorities. A well in this locality gave me 63 grains of total residue, with 14 grains of organic matter and nitric acid, in the winter of 1878-9; and another well, *a few yards* further on, was analysed by the late Dr. Dundas Thomson (in 1854, as I afterwards discovered), with precisely the same results: the figures were almost identical. This would appear to show that for the last twenty-five years the well-waters in that particular spot have not varied in composition, *though there is evidence of contamination.*

XII. *Observations.*

The depth of a well has no influence upon the quantity of residue its water leaves upon evaporation. Thus, I found the total residue yielded by the water of a shallow well in the grounds of the Countess of Leven, at Roehampton, to be 38 grains. This well is 14 feet deep. Another, nearly the same depth and not very far distant, gave 119 grains.

The purer a water is the better it dissolves lead (as I have shown in my paper read at the meeting of the British Association at Norwich in 1868), and many a good spring water has thus been spoiled by storing in lead cisterns, being supplied by lead pipes, or pumped through a leaden pump. Slate cisterns are preferable, but they should not be soldered at the joints by red-lead, as is usually done.

Many years ago I showed that *boiler deposits* in all parts of the world (with the exception of a few special cases and marine boilers) *are due to carbonate of lime precipitated by the expulsion of carbonic acid from the boiling water.* They consist almost entirely (over 90 per cent) of carbonate of lime, similar to the mineral aragonite, in whatever country they are examined, as I showed for the first time in 1868 (*Scientific Review*, January, 1868).

I have tested a very great number of spring- and well-waters for *phosphoric acid*, and have *usually* found it *entirely absent*. Its presence is *always a bad indication.*

In the above analyses the microscope was invariably used for the examination of any residue deposited by the water on standing. In cases of sewage contamination through old-fashioned brick drains, it has more than once enabled me to detect dangerous waters by proving infiltration when the analysis was tolerably good. I am at present again occupied with some experiments on the organic matters of well-waters, and when these are completed I hope to give a brief account of them and of some tests to which a sample of water must be subjected in order to arrive at its true nature, and to be enabled to pronounce with certainty upon its fitness for drinking or other purposes.

Transmission of the Mineral Matters of the Soil into Vegetables.—M. Baudrimont has ascertained experimentally that recently precipitated tricalcic phosphate, calcic fluoride, ferric hydrate, hydrate silica, and aluminic hydrate are all soluble in an aqueous solution of carbonic acid.

PRELIMINARY NOTE ON AN ATTEMPTED SYNTHESIS OF THE HYDROCARBON PHENYL-NAPHTHYL, OR PHENYL-NAPHTHALEN.

By WATSON SMITH, F.C.S., F.I.C.

IN trying a series of experiments, last December, on the action at a red-heat of brom-naphthalen on naphthalen, both alone and in presence of soda-lime, by which dinaphthyl was pretty plentifully obtained (see *Journ. Chem. Soc.*, May, 1879, and *Ber. Deut. Chem. Ges.*, xii., No. 6, p. 674), the idea occurred to me that very possibly, by taking benzene instead of napthalen, I might get the hydrocarbon phenyl-naphthyl or phenyl-naphthalen formed, according to the little scheme—

$$\underbrace{C_{10}H_7Br}_{\text{Brom-naph-thalen.}}.\underbrace{HC_6H_5}_{\text{Benzene.}}$$

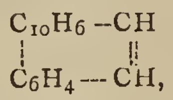
The proportions indicated by the desired reaction were taken, and the mixture was passed, first, alone through the red-hot tube; and secondly, over soda-lime, which had been arranged to form a layer in the tube. The mono-brom-naphthalen was dissolved in the benzene, and the fluid was dropped into the tube by the arrangement described and sketched in CHEMICAL NEWS (vol. xxxix., p. 268). In the first case but little decomposition took place, even at the high temperature employed, and therefore but little hydrobromic acid was evolved. The result on subsequent examination was a small quantity of a resinous body boiling above 300° together with small quantities of other products (probably diphenyl, &c.). In the second case, a large quantity of naphthalen was formed, and came over. It is very probable, in presence of the soda-lime, the following reaction would take place:—

$$C_{10}H_7Br + 2C_6H_6 + NaOH = \\ = \underbrace{C_{10}H_8}_{\text{Naphthalen.}} + NaBr + H_2O + \underbrace{C_6H_5 - C_6H_5}_{\text{Diphenyl.}}\text{.*}$$

I now determined to try a reversal of the already mentioned mixture, taking one of brom-benzene and naphthalen; for it struck me this mixture would be preferable to the other, inasmuch as the *boiling-points* of the two constituents (brom-benzene and naphthalen) are not far apart, as in the former case, and I thought it not at all impossible that in like manner they might be more nearly on the same level with regard to what might be termed their *dissociation-points*, or at all events those points where the affinities of the H and Br are sufficiently weakened in their respective molecules ($C_{10}H_7H$ and C_6H_5Br), by the high temperature in the tube, that they shall incline to split off and effect a union, probably now lie much more nearly together than in the former case. Such a proximity is desirable as indicating, furthermore, a probable putting forth of powers of affinity in the nascent state, at about the same instant, and with something approaching the same degree of force. This was the consideration which led me to change the mixture as described, and I can now state that the results amply confirmed the stability of the theoretical ground taken in this case.

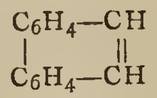
The mixture was passed through the red-hot tube drop by drop; hydrobromic acid was plentifully evolved, the amount of carbon separated was not great, and on subsequent examination of the black tarry-looking mass which had come over it was found to contain undecomposed naphthalen and brom-benzene, a very small quantity of benzene, diphenyl,—a body distilling over above 360°, but not at nearly so high a temperature as the dinaphthyls,—and, finally, iso-dinaphthyl, with other yellow and red high-boiling products. It was found quite easy to separate the new body from the iso-dinaphthyl, since it is quite easily soluble in spirits of wine, in which iso-dinaphthyl is almost totally insoluble. The new substance crystallised from boiling dilute alcohol on cooling, in microscopic white crystals, agglomerated in tufts, and difficult to distinguish whether as needles or thin lanceolate plates. It was now placed on a filter, washed once or twice with cold dilute alcohol, and then water, and finally dried at 80°. The faint yellowish white mass was now submitted to sublimation, whereby beautiful little transparent plates were obtained, with a blue fluorescence resembling that of pure anthracen, and having a melting-point of 101° to 101½°. The odour of the vapours of this body resembles that of oranges. In the treatment with alcohol it was observed that one portion separated out from strong alcohol on cooling and standing over night, but the other portion refused to do so till after much more concentration. I think it very possible that these may turn out to be two isomeric bodies, and since two isomeric phenyl-naphthalens are possible it is quite probable they are here present. To this subject I am now giving the closest attention, and hope speedily to settle the question and be able to furnish final results.

The synthesis of phenyl-naphthalen, I need scarcely say,—since Graebe has so beautifully shown it to be the foundation, so to say, of chrysen, just as diphenyl is of phenanthren,—is a matter of no small interest in the territory of the aromatic compounds. Graebe finds (*Ber. Deut. Chem. Ges.*, xii., 1078), that, on heating chrysochinon with soda-lime, a hydrocarbon is formed having the composition of, and appearing to be no other than, phenyl-naphthalen, and so to chrysen he assigns the formula—



$$\begin{array}{l} C_{10}H_6 - CH \\ \;\,| \qquad\;\; \| \\ C_6H_4 - CH, \end{array}$$

just as phenanthren is formulated—



$$\begin{array}{l} C_6H_4 - CH \\ \;| \qquad\;\; \| \\ C_6H_4 - CH \end{array}$$

on account of its similar relationship to diphenyl.

University Laboratory, Zurich,
June 28, 1879.

ON THE DIFFERENT ANILINE-BLACKS.*

By JUSTUS WOLFF.

(Concluded from vol. xxxix. p. 273.)

THE third series of aniline-blacks, of which the nigrosin which I invented is a link, we call the nigrosin series. This nigrosin was manufactured since 1863 in large quantities, and has been and is used for dyeing black and grey on wool, silk, and leather, especially in Germany, notwithstanding its high price (33/- per pound) at which it was sold during the first two years. A very large firm used it in great quantities for dyeing silk sunshades silver-grey, proving that it stands the action of light and air in no small degree. Its solution in alcohol in combination with varnish-producing oils and resins was used for black varnishing.

The first nigrosin was manufactured in 1863 by heating a mixture of 44 parts of aniline, 20 parts of stannous chloride, and 11 parts nitro-benzene in the first four hours to about 190°, and after that time to 220° to 230° for a sufficient length of time (taking about nine to twelve hours) until a sample drawn and poured into boiling water communicated to the latter a pure yellow colouration. At that point the unaltered aniline in the melt was driven off by a current of steam, the melt separated from the liquid

---

* I would argue from this that most probably the $C_{10}H_7Br$ (boiling at 277° is much more stable at the high temperature than the benzene (boiling at 80°), which is first decomposed. The nascent hydrogen then attacks the $C_{10}H_7Br$, diphenyl being at the same instant formed, and, in presence of NaOH, H_2O, NaBr, and $C_{10}H_8$ are yielded—a reaction in detail taking place, and so obviating the formation of the desired phenyl-naphthalen.

* All temperatures are given in Centigrades.

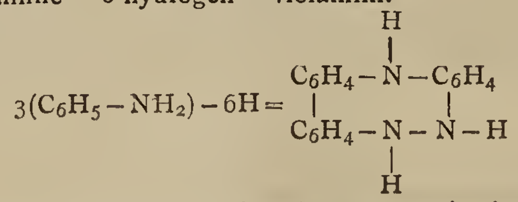
(produced by condensation of steam), dried, powdered, and sold as nigrosin. It is still in the market, and is used for the above-mentioned purposes.

I soon found out that the presence of stannous chloride was not essential for the production of that colouring matter, but that many other metallic salts would do the same, and even that it could be obtained without any metallic compounds at all, but only with aniline salt and nitro-benzene.

Inferring from that reaction that the nitro-benzene may be acting in this mixture as an oxidising agent, I used other oxidising compounds in its place—for example, arsenic acid—which, acting on aniline salt or a mixture of aniline and aniline salt in the proper proportions, produced also a fine nigrosin.

In trying to obtain this colouring matter in a water-soluble state I found that nigrosin made from impure aniline (containing toluydin) is not soluble in boiling water, but the latter dissolves a brown-yellow colouring matter; if the remainder is boiled two or three times more with water (slightly acidulated with hydrochloric acid), then it will dissolve some more nigrosin. The fourth extraction with slightly acidulated boiling water yields nigrosin in solution, and also all the following extractions. The fact that chlorine gas produces nigrosin with aniline in proper proportions and at a suitable temperature proves that it is in the first instance a product of dehydrogenation, and, following the process closely, we find that violanilin is formed in the first stage of the process, as the following formula represents:—

3 aniline − 6 hydrogen = violanilin.



$$3(C_6H_5-NH_2)-6H=\begin{array}{l}\qquad\quad H\\ \qquad\quad |\\ C_6H_4-N-C_6H_4\\ \;|\qquad\qquad\quad |\\ C_6H_4-N-N-H\\ \qquad\quad |\\ \qquad\quad H\end{array}$$

The quantities of the dehydrogenators in the mixtures intended for the production of nigrosins being only sufficient to dehydrogenate and condense not quite the half of the weight of the aniline, we have, after this first stage of the process (the formation of violanilin), and when the dehydrogenation is finished, before us a mixture consisting principally of violanilin and aniline salt. By further heating this mixture to about 220° to 230° we see gradation-changes taking place in the colour of the mass or melt, from violet-blue to dark-blue, and later on to greenish black, whilst ammonia is formed.

Violanilin (prepared as pure as possible either from magenta-refuse or by the processes above described) heated with aniline salt (or mixtures of aniline and aniline salt) to 220° to 230° for a sufficient length of time yields water-soluble and insoluble nigrosin, besides ammonia.

Triphenyl-violanilin (the base of spirit-soluble indulin), or the spirit-soluble indulin itself, heated with aniline salt to 220° to 240° for a sufficient length of time, yields soluble and insoluble nigrosin, but no ammonia is formed.

Pure nigrosin is produced in the following way:—A mixture of 22 parts chlorhydride of chemically-pure aniline and 10 parts of chemically-pure syrupy arsenic acid (containing 70 per cent of dry acid) is heated for from four to five hours up to 190° in a glass or enamelled iron vessel, whilst well agitated from time to time. After that time the temperature is raised up to 220° to 230°, and kept at that heat for such a length of time that a drawn sample dissolves with a faint yellow colour in neutral boiling water. Then a strong solution containing a little more caustic soda than is sufficient to neutralise the acids in the melt is added, and the thus liberated unaltered aniline (besides some diphenylamin) is completely driven off by a current of steam. The remaining nigrosin base is separated from the alkaline solution, repeatedly washed with boiling water, and then treated with water acidulated with an excess of hydrochloric acid by boiling it for a sufficient length of time until nearly all is dissolved.

To the solutions obtained in that manner caustic soda is added, which separates the nigrosin base. The latter is collected on a filter, washed, and re-dissolved in slightly-acidulated boiling water in order to obtain a strong solution of nigrosin. By addition of salt to that solution and cooling nigrosin is precipitated, which, collected on a filter and well washed, is again dissolved in pure distilled boiling water (the quantity of the water should be not quite sufficient to dissolve all the nigrosin whilst boiling), the solution filtered whilst boiling, separates nigrosin by cooling. This last operation, several times repeated, yields the pure nigrosin.

If the process has heen conducted carefully, and the temperature kept in the limits given above, then nearly all will be soluble nigrosin, which, made from chemically-pure aniline, will be a blue colouring matter, whilst from aniline containing toluydin in small quantities the black shades of nigrosin are obtained in the manner given above.

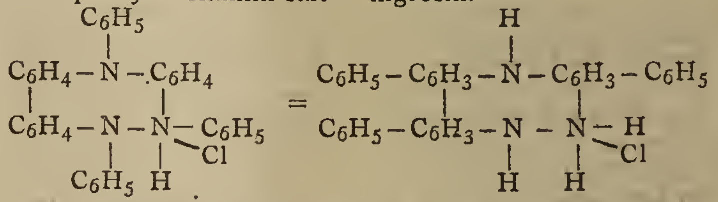
100 parts of pure nigrosin dried for seventeen hours at 130° contain 7·2886 parts of hydrochloric acid. The average of four elementary analyses of the pure nigrosin base, dried at 130° to 140° for twelve hours, shows that it consists of 86·368 per cent carbon, 5·387 per cent hydrogen, and 8·410 nitrogen. Consequently the formula for the nigrosin base is $C_{36}H_{27}N_3$, and for the nigrosin $C_{36}H_{27}N_3ClH$. This is also the formula for triphenyl-violanilin. The conversion of triphenyl-violanilin into the nigrosin base (both being isomeric) is therefore effected by an intramolecular change.

As the triphenyl-violanilin yields by dry distillation diphenylamin and aniline, and the nigrosin base does not yield any of them but substances belonging to the derivatives of di- and triphenylen-diamin it is easily inferred that in the triphenyl-violanilin the hydrogens in the appendants are substituted by phenylen, C_6H_5, whilst in the nigrosins the hydrogens of the nuclei are substituted by phenylen,

$C_6H_3-C_6H_5$.

The triphenyl-violanilin salt is therefore converted into nigrosin by intramolecular transposition.

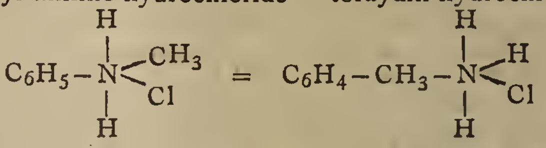
Triphenyl-violanilin salt = nigrosin.



$$\begin{array}{l}\quad C_6H_5\\ \qquad |\\ C_6H_4-N-C_6H_4\\ \;|\qquad\qquad |\\ C_6H_4-N-N\overset{}{-}C_6H_5\\ \qquad |\quad\; |\diagdown Cl\\ \quad C_6H_5\; H\end{array}=\begin{array}{l}\qquad\qquad\qquad H\\ \qquad\qquad\qquad |\\ C_6H_5-C_6H_3-N-C_6H_3-C_6H_5\\ \qquad\qquad\;\, |\qquad\qquad |\\ C_6H_5-C_6H_3-N-N-H\\ \qquad\qquad\qquad |\quad\; |\diagdown Cl\\ \qquad\qquad\qquad H\quad H\end{array}$$

Hofmann published, in the *Ber. der Deut. Chem. Gesell.*, 1872, p. 720, a similar case in the conversion of methyl-aniline hydrochloride into toluydin hydrochloride by heating the former to 230° to 250° for a whole day.

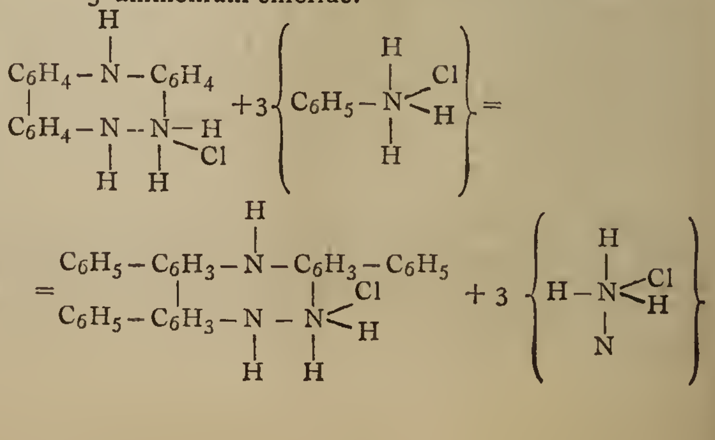
Methyl-aniline hydrochloride = toluydin hydrochloride.



$$\begin{array}{l}\qquad\quad H\\ \qquad\quad |\\ C_6H_5-N{<}^{CH_3}_{Cl}\\ \qquad\quad |\\ \qquad\quad H\end{array}=\begin{array}{l}\qquad\qquad\qquad H\\ \qquad\qquad\qquad |\\ C_6H_4-CH_3-N{<}^{H}_{Cl}\\ \qquad\qquad\qquad |\\ \qquad\qquad\qquad H\end{array}$$

The formation of nigrosin from violanilin is represented in the following equation:—

1 violanilin salt + 3 aniline hydrochloride = nigrosin + 3 ammonium chloride.

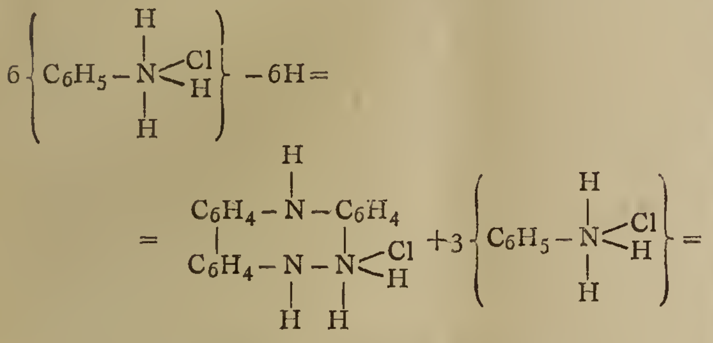


$$\begin{array}{l}\qquad H\\ \qquad |\\ C_6H_4-N-C_6H_4\\ \;|\qquad\qquad\; |\\ C_6H_4-N-N-H\\ \qquad |\quad\; |\diagdown Cl\\ \qquad H\quad H\end{array}+3\left\{\begin{array}{l}\qquad\quad H\\ \qquad\quad |\\ C_6H_5-N{<}^{Cl}_{H}\\ \qquad\quad |\\ \qquad\quad H\end{array}\right\}=$$

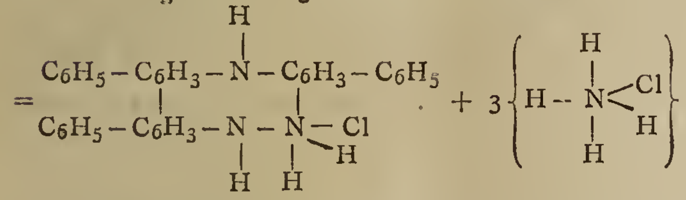
$$=\begin{array}{l}\qquad\qquad\qquad H\\ \qquad\qquad\qquad |\\ C_6H_5-C_6H_3-N-C_6H_3-C_6H_5\\ \qquad\qquad\;\, |\qquad\qquad |\\ C_6H_5-C_6H_3-N-N{<}^{Cl}_{H}\\ \qquad\qquad\qquad |\quad\; |\\ \qquad\qquad\qquad H\quad H\end{array}+3\left\{\begin{array}{l}\quad\; H\\ \quad\; |\\ H-N{<}^{Cl}_{H}\\ \quad\; |\\ \quad\; N\end{array}\right\}$$

And consequently the production of nigrosin from aniline hydrochloride—

6 aniline hydrochloride — 6 hydrogen = 1 violanilin hydrochloride and 3 aniline hydrochloride.



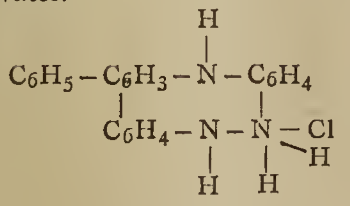
= 1 nigrosin and 3 ammonium chloride.



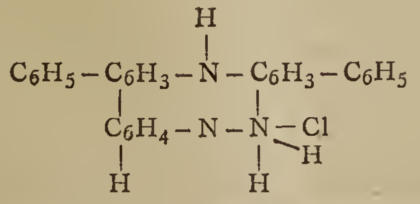
In the formation of indulin, as well as in that of nigrosin, a phenylation takes place. In the first case the nitrogen of the aniline acts as a triad, whilst in the violanilin the nitrogen of two of the appendants are triads, and that of the third appendant acts, being a compound with an organic acid at a low temperature as a pentad, which at higher temperatures starts dissociating and becoming triadic. Simultaneously it will be acted upon by the aniline triadic nitrogen, giving away its hydrogen and replacing it with the nucleus of the aniline; after that is done the other appendants are acted upon in the same way.

In the formation of nigrosin the nitrogen in the aniline and one, or also consecutively two, and three of the nitrogens in the violanilin act as pentads in combination with an inorganic acid which will not dissociate but at a very high temperature, and before this is reached the nuclei—C_6H_4—of the violanilin on the one part, and C_6H_5 of the aniline on the other part, will act one on another, and nucleus substitutions will take place whilst ammonia is formed. Also in the conversion of triphenyl-violanilin into nigrosin the intra-molecular transposition creating this conversion is caused by the action of nitrogen as a pentad in the triphenyl-violanilin hydrochloride molecule.

The same may be said of triphenyl-mauvanilin, which, by the action of aniline hydrochloride, is converted into the brownish black nigrosin. Of course there are also nigrosins in which instead of three only two or one substitution has taken place, and such are insoluble in neutral and acidulated water.



And—



It is very probable that by the action of aniline hydrochloride on aniline-blue (triphenyl-rosanilin) at a temperature of 220° to 240°, by which De Laire's aniline-brown is formed, an analogous reaction takes place This brown is also produced by the action of aniline hydrochloride on magenta and violet, analogous to the formation of nigrosin from violanilin; and also analogous to the formation of nigrosin. Furthermore, it can be produced by the action of a dehydrogenator on an excess of a mixture of one molecule aniline hydrochloride and two molecules of toluydin hydrochloride. Here we meet with quite a new series of colouring matters, viz., those which can be obtained by simple intra-molecular transposition from other colouring matters caused by the action of its nitrogens in a pentadic state. These new colouring matters can also be obtained by dehydrogenation and subsequent phenylation of aniline, or mixtures of aniline and toluydin with pentadic nitrogens.

It is to be supposed that many reactions of this kind may occur, and they may be generalised as follows:—

I. By causing one or more of the constituent parts of a molecule to act on the other parts with another atomicity than they acted with in producing the original molecule, the latter can be converted into an isomeric compound (with different positions of its constituents), viz., intra-molecular transposition can take place.

II. By causing one or more of the constituent parts of a molecule to act at different times with different atomicities on the other parts, isomeric molecules with different positions of their constituents can be produced.

The pure blue nigrosin, whose production from chemically pure aniline salt has been given above, dissolves with a dull blue colour in neutral water, turning brighter and greener by addition of acid (hydrochloric acid principally). Its solutions in acidulated water possess a remarkable blood-red fluorescence, increasing by addition of more acid up to a certain proportion, and all the blue and black nigrosins possess this remarkable qualtity more or less.

This fluorescence is sometimes so strong that in a solution of blue or black nigrosin, which contains only such a small quantity that by looking through this solution no colouration is perceivable, it reflects a brownish red tint, especially before a black background, and the sun's rays falling upon it directly, it then looks as if very small particles of metallic copper were suspended in the liquid and moving about.

The slightly acidulated solutions in water dye wool, silk, China-grass, cotton, and certain other fibres (at about 80°) blue, the dye going on the fibre very slowly. If the bath is strong enough it will dye wool, silk, China-grass, and certain other fibres a fine blue-black (which, when deep enough, will stand light, air, and soap, but not the fulling process) in about one to one and a half hours without impairing the natural gloss of the different fibres. The same is the case with the other blue and black nigrosins; as all the nigrosins go on very slowly, they are especially adapted for dyeing yarns and goods evenly.

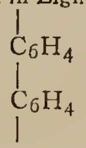
The following mixtures, treated in the same manner as described with that of aniline salt and arsenic acid, produce the different shades of the blue and black nigrosins:—60 parts of hydrochloride of chemically pure aniline and 10 parts chemically pure nitro-benzene yield a dark blue dyeing nigrosin. The same mixture with 1 part cupric or cupreous chloride added to it yields a very fine deep blue-black. 60 parts of aniline hydrochloride (the aniline containing 2 per cent of toluydin) and 10 parts nitro-benzene (made of benzene containing 2 per cent of toluen) yields a blue-black dyeing colouring matter, which, by addition of certain metallic compounds (as, for example, cupric chloride, &c.), is considerably deepened.

By application of nitrobenzene in the nigrosin process other colouring matters besides nigrosin are formed in larger proportions than by application of certain other dehydrogenators, deriving from the action of intermediate products of decomposition of nitrobenzene, and remaining to the greatest part insoluble in neutral and acidulated water. By increasing the proportions of toluydin in the mixtures for nigrosin the black goes more and more over in jet-black and brownish black, which shades, by addition of copper and certain other metallic salts, are rendered deeper. Of course a considerable practice and a great deal of experience is needed for the production of the different shades and qualities of the blue and black water-soluble nigrosins (patented in England, France, and the United States in 1876), as in this process the regulation of temperature at certain periods is of the greatest importance, for, if not carefully watched, a considerable quantity of by-products will be formed.

The nigrosins are slightly soluble in weak alkaline solutions by boiling. They dissolve easily in benzene, petroleum, and certain oils, especially when alkaline, with a bright purple colour, and when sour with a fine green-blue shade. Oxidising agents convert the blue and black nigrosins (especially when dyed in lighter shades on the fibre) into dull and reddish grey violets. Reducing agents render them colourless, forming leuco-nigrosins. Very remarkable is the resistance of the blue and black nigrosins against strong nitric acid, which, when dyed deep black, will, with nitric acid of even 1·5 sp. gr., only change to a very deep, nearly black-green after many hours of action, and then when the acid is washed off, the black does not seem to be changed at all. By this resistance against the action of strongest nitric acid, the blue and black nigrosins distinguish themselves from all other colouring matters.

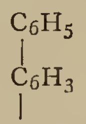
Therefore, it is very probable that the chemical constitution of both series may be typically analogous, and thus the formulæ III., IV., and V. given by me to the Lightfoot black gain more probability, showing that both series have at least in common the nucleus substitution or connection of nuclei.

Substitution in Lightfoot Black.



$$\begin{array}{c} | \\ C_6H_4 \\ | \\ C_6H_4 \\ | \end{array}$$

Substitution in Nigrosin.



$$\begin{array}{c} C_6H_5 \\ | \\ C_6H_3 \\ | \end{array}$$

Further investigations may prove the analogy of both series—the one which I described by the formulæ III., IV., and V., and that of nigrosin.

The purer the aniline of which both are produced the bluer the shades of the blacks, and the blue and black shades of both are deepened by addition of certain metallic compounds. The Lightfoot-black turns green with acids, and the solutions of nigrosin also turn green with acids.

The application of the different nigrosins in dyeing is the same for all, and like that given for the blue nigrosin. Nigrosin can also be used for printing blue, grey, and black on silk and wool in several ways, of which one is, to dissolve it in aniline or aniline salt, thickening the solution, and then to steam, wash, and dry. A solution of nigrosin in glycerin can also be used. Of course the insoluble and also soluble blue and black nigrosins can be converted with oil of vitriol into their respective mono-, di-, tri-, and tetra-sulphonic acids and their salts, which of course will improve the insoluble nigrosins and make them marketable, but not so the soluble nigrosins. The price of the nigrosins is not low enough that they could compete with the cheaper black colouring matters, but the beauty of their shades and their easy application, combined with resistance against light, air, and soap (except in the fulling process), will secure them a good market, especially for dyeing the more costly wool fabrics, China-grass, and above all silk. It is especially adapted for dyeing the last-named material a fine black without increasing its weight more than a few per cents, and being easily applied it could help to do away to some extent with the contemptible custom of weighting black silk fabrics. And, indeed, there should be put a stop to this pernicious practice, which reduces the famous durability of the silk fibre to its one-hundredth part by the corrosive action on the fibre of the materials used for weighting. The public pays the full price of silk for a material which contains only one-third of it (and that in a deteriorated state), and two-thirds of substances which have very little value compared with that of silk, and spoil it too. I know English manufacturers who send their silk to France for being dyed black and have it sent back for working it up, only for that reason, because in France they are able to increase the weight of silk whilst dyeing it black, much more than they can do in England; and therefore the silk dyed black in France will be cheaper by far than that in England, even after paying the freight to France and back. The result of such practice is a beautiful black silk fabric, changing into rags remarkably quick in the possession of the buyer.

Of course much has been said already authoritatively against this fraudulent adulteration, but it will not have any effect until numerous analyses of black silk fabrics have been made and their results published with the names of the respective firms manufacturing or selling them, and it would be a meritorious undertaking to organise in this manner a crusade against such offences.

COMPOSITION AND QUALITY OF THE METROPOLITAN WATER.

May, 1879.

The following are the returns of the Society of Medical Officers of Health:—

	Appearance in 2 foot Tube.	Ammonia.		Nitrogen as Nitrates, &c.	Oxygen used to Oxidise Organic Matter.	Total Solids.	Lime.	Magnesia	Chlorine	Sulphuric Anhydride.	Hardness on Clark's Scale.	
		Saline.	Organic.								Before Boiling.	After Boiling.
		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Degrees.	
Thames Water Companies.												
Grand Junction	Clear	0·000	0·006	0·141	0·067	21·11	7·630	0·790	1·224	1·53	14·3	3·7
West Middlesex	Clear	0·000	0·006	0·135	0·070	21·00	8·170	0·860	1·152	1·66	14·3	3·7
Southwark and Vauxhall	Clear	0·000	0·006	0·111	0·069	21·80	8·060	0·612	1·152	2·03	13·2	3·3
Chelsea	Clear	0·000	0·006	0·135	0·058	20·20	7·280	0·540	1·224	2·00	14·3	3·3
Lambeth	Clear	0·000	0·007	0·135	0·036	20·90	7·700	0·756	1·152	1·53	14·3	4·6
Other Companies.												
Kent	Clear	0·000	0·004	0·295	0·004	20·70	10·410	0·936	1·512	3·03	17·6	6·0
New River	Clear	0·000	0·004	0·135	0·030	20·70	7·590	0·468	1·152	1·16	13·7	3·3
East London	Clear	0·000	0·006	0·105	0·052	23·00	7·840	0·840	1·296	2·07	14·7	4·6

The quantities of the several constituents are stated in grains per imperial gallon.

Note.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

C. Meymott Tidy, M.B.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

June 26, 1879.

Earl Rosse in the Chair.

An extra meeting of this Society was held on the above date at Cooper's Hill Indian Engineering College on the invitation of Col. Chesney, R.E.

Prof. Unwin, of the College, read a paper on "*Experiments Relating to the Friction of Fluids on Solid Surfaces against which they rub.*" It has long been known that a board dragged through water suffers a resistance varying in some way as the square of the velocity, that a stream has a uniform motion at such a velocity that the component of the weight of the water down its inclined bed is balanced by the frictional drag on the bottom. The fluid in the neighbourhood of the stream is known not to move as a solid mass, the centre moving faster than the sides, and the different fluid layers rub against each other. The adhesion of the fluid to the solid, against which it moves, also gives rise to a sliding or shearing action. Our knowledge of the subject has hitherto been gained from observations on pipes, streams, and from the experiments of the late Mr. Froude with a plank of wood drawn through the water of a canal. It is desirable to have a set of laboratory experiments, however, as the conditions can be varied more than can be done by such methods, and for this purpose the author had designed a special apparatus. In Mr. Froude's experiments there was a practically unlimited mass of water and a definitely limited extent of solid surface; and his results are not free from certain anomalies. The author thought it might be instructive to try the other case of a limited mass of water, and a virtually unlimited surface; a disk in rotation gives such a surface. In some respects a cylinder would (as suggested by Prof. Ayrton) be the simplest to treat theoretically, but there are experimental difficulties in its way. The apparatus of the author consists of a metal disk rotated on a vertical axis in a vessel of water; and the problem is to determine its resistance to rotation, since this will be equivalent to the water friction upon it. Within the outer vessel is placed a thin copper chamber, the diameter of which is unalterable but the depth is variable at pleasure. The disk is placed concentrically inside this chamber, where there are two cheese-shaped masses of water, one above and one below the disk, which are dragged into rotation next the disk and retarded next the sides of the pan. The couple required to rotate the disk is equal to the couple exerted by the disk or the fluid when the motion is uniform. Hence the tendency of the chamber to rotate is measured by suspending the latter from three wires in a manner similar to the bifilar suspension of magnets. An index marks whether it rotates or not on a graduated scale, and a weight suspended by a cord measures the force required to keep the index at zero. Let M be the moment of the fractional resistance of the disk; N the number of revolutions per second. Then $M = CN^x$, where C and x are constants. The author has obtained a number of results, which are, however, not yet ready for publication. He mentioned, however, that a rough cast-iron disk has a frictional resistance almost exactly as the square of the velocity; whereas a turned brass disk gave a value of x decidedly less than 2. The resistance is a little greater when the mass of water is larger. These results were calculated for a speed of 10 feet per second. The author hopes to try the effect of temperature, &c., on fluid friction, and viscous as well as thin fluids.

Prof. Unwin also exhibited a piece of apparatus with which he hopes to study the stress of rivetted plates under shear by means of elastic substances, such as caoutchouc. He purposes to stretch the rivetted caoutchouc and photograph the appearance of stress-lines upon it.

Lieut. G. S. Clark, R.E., explained the process invented by Prof. McLeod and himself for determining the absolute pitch of tuning-forks. Unlike other methods this is an optical one, and consists in arranging the tuning-fork to vibrate in front of a rotating drum whose periphery is marked with dots or fine lines at equal intervals. A microscope was arranged to comprise in its field of view the edge of the fork and the several of the intervals on the drum, so that when the drum was rotated at a rate which made the speed of an interval equal to the period of the fork, a set of prominences or waves, in width equal to an interval, were visible, the body of the wave being caused by the advance and recession of the fork in its vibration. The rotation of the drum was regulated by an air regulator devised by Prof. Unwin, the observer himself quickening or slowing the drum so as to keep the prominences steady. The time was got by an electric clock designed by Prof. McLeod. An aniline glass pen was used to mark the beginning and end of the periods of observation on the drum. A counter was also employed to give the number of revolutions. The pen and counter were actuated by electricity through the medium of a key. In these experiments a König fork, giving 256 vibrations per second, correct at 16·1° C., was tested and found to give 256·2966 vibrations per second. Frequent bowing did not alter the phase. Fixing the fork rigidly, as in a vice, did so. The temperature coefficient for König's forks (0·00011 for each degree Centigrade) was confirmed by these experiments. Forks of different octaves were compared; audible beats could be counted; and modifications of Lesage's figures seen. This optical method is preferable to audible ones, because of its independence of the ear and the fact that nothing is attached to the fork itself.

Prof. Guthrie enquired if the periods of the forks had been found to alter through use or magnetisation.

The Author said that he had not yet tested these points.

Prof. McLeod instanced an old König fork which was correct at 16·1° C., requiring now a temperature of 25° C. to make it so.

Lord Rosse suggested the use of the regulators employed with equatorial clocks to keep the rotation of the drum steady.

Capt. Abney enquired if a difference of vibration had been detected between the beginning and end of a series of observations. None had been certainly observed.

Prof. McLeod then described an electric clock used in the foregoing experiments. A zinc and steel compensating pendulum moved by its own gravity; but at each beat made and broke a battery circuit by means of two bent springs, one on either side. The current passing through an electro-magnet detained a bent lever until the pendulum swung to the other contact. By this contrivance time was marked. Prof. McLeod found that the platinum contacts frequently stuck together in these experiments; but this defect had been cured by the use of a liquid shunt of dilute sulphuric acid, which destroyed the extra current. This remedy had been suggested to him by Lord Rayleigh. Prof. McLeod demonstrated the complete success of this device, which acts as well as a condenser shunt. He had also observed a curious effect with these liquid shunts, which as yet he could not explain. Two shunts, having the same acid in both, were employed, one shunting the extra current from four Daniell cells and one that from two Daniell cells. The first showed evolution of H and O gas, the platinum electrodes being unaffected. The second showed no evolution of gas, but one platinum plate was dissolved away and deposited in a black powder on the other. He also exhibited a new cell formed of zinc and mercury plates, with zincic iodide solution and mercurous chloride salt. Red iodide of mercury is formed at the negative electrode. The E.M.F. is seven-tenths of a Daniell cell, but the interval resistance very low and the cell very constant, while there is no local action.

Prof. Guthrie suggested that as the extra current was really a succession of sparks the platinum might be carried bodily over from one electrode to the other.

Mr. F. H. Varley stated that Mr. F. Higgins had observed a similar effect with carbon electrodes in a voltameter, one carbon falling away into a fine powder, and due perhaps to the disintegrating action of liberated gases. He had also himself seen a platinum wire in contact with a carbon one eaten thin and drawn into very fine silky pens, while the carbon was stained blue, although the current passing was of low tension.

Mr. Chandler Roberts suggested that perhaps a hydride of platinum was formed in the case mentioned by Prof. McLeod.

Prof. Guthrie suggested experiments with fluorescent liquid shunts in the dark.

Mr. J. W. Clark then described some experiments on the surface tension of sulphurous anhydride sealed in a capillary tube within a second tube containing the same substance. He found that at low temperatures the level of the liquid is lower in the narrow than in the wide tube. As the temperature rises the meniscus in the narrow tube descends, till at about 156° F. it is level with that of the wider tube, both surfaces being slightly concave. About this temperature the surfaces become plane then concave, the level in the wide tube becoming higher than that in the narrow one. These experiments are being continued, and Mr. Clark's other results will be communicated to the Society later on.

Prof. Guthrie proposed a vote of thanks to Colonel Chesney.

NOTICES OF BOOKS.

Note sur la Déphosphorisation au convertisseur Bessemer et sur la Déphosphoration des Fontes. Par M. Pourcel, Ingenieur Chef des Aciéries de Terrenoire. St. Etienne: Théolier Frères. 1879.

This is a reprint of a Paper read by M. Pourcel at the meeting of the Société de l'Industrie Minérale, held on the 7th June last. After describing the rise and progress of the Thomas and Gilchrist method of dephosphorising iron, M. Pourcel gives an interesting account of his visit to Messrs. Bolckow and Vaughan's works, at Eston, in May last, where the process was carried out in his presence. The method of working in no way differed from that described by Messrs. Thomas and Gilchrist, in their Paper read before the Iron and Steel Institute in May last, and republished in the Chemical News (vol. xxxix., p. 219). The resulting metal contained—

C	0·171
Mn	0·160
P	0·223
S	0·037
Si	traces.

The crude iron used was Cleveland pig, containing 1·8 of P, 3 of Si, and 3·2 of C. The addition of 10 per cent of spiegeleisen at the end of the operation increased the quantity of P from 0·14 per cent to 0·223.

From his observations on this occasion M. Pourcel draws two conclusions. The first is, that the neutralisation of the silicic acid produced by the oxidation of the silicium in the crude pig is fully effected by the addition of a mixture of lime and iron oxide; and secondly, that overblowing, by prolonging the oxidising action, determines the scorification of the iron phosphide. The neutralisation of the silicic acid, adds M. Pourcel, gives rise to a large quantity of slag, which occupies a considerable space in the converter, diminishing its size from one-quarter to one-third. Hence, with very silicious pig, this change operated upon falls from 8 or 9 to 6 or 7 tons. The "overblowing" increases the proportion of ferric peroxide dissolved in the bulk of metal, and consequently necessitates the addition of a considerable quantity of manganese—as much, indeed, as 2 or 3 per cent, if we want to avoid all danger of honeycombing. In the operations as carried out at Eston, M. Pourcel thinks that the "overblowing" was not kept up sufficiently long, because the metal of the last test, taken just before the addition of the spiegeleisen, contained 0·14 per cent of P, and that the manganese added in the spiegeleisen—1·7 per cent—was not sufficient, only traces of it being found in the resulting metal. The other defects in the process, as pointed out by M. Pourcel, are the several stoppages necessitated by having to take tests at different points of the operation, the uncertainty of knowing when the metal is sufficiently dephosphorised, and the explosions which result from the addition of the spiegeleisen—defects which the author looks on as being inherent at present, but which he hopes to see disappear in the course of working. Another very just remark which he makes is that the addition of spiegeleisen adds to the amount of P contained in the finished metal, not only from containing certain proportions of the very plague we are trying to get rid of, but by causing the reductions of part of the phosphate of iron in the slag owing to the liberation of large quantities of CO. The production of CO must therefore be reduced to a minimum, while the oxidising action of the air must be increased so that the P may not only pass into the slag, but remain fixed in it. M. Pourcel seems to think that if the P could be made to enter into the slag in the form of calcic phosphate, instead of iron phosphate, it would not be so liable to be reduced by the CO.

M. Pourcel recommends that the fumes which escape from the converter during the process of "overblowing" should be analysed; he thinks the greater portion of the iron phosphate is thus carried off. With respect to the part played by the lime in the process, M. Pourcel is at variance with most of the speakers at the meetings of the Iron and Steel Institute held in May last. The lime, he says, having played an active part of a neutralising base in the first part of the operation, thereby preserving the lining of the furnace from the corroding action of the silica, does not play a passive part during the operation of "overblowing." Calcium phosphate is a perfectly infusible body, the formation of which is not caused in this case by the action of the affinities at work, whether the lime is in the free condition or combined with the silica. M. Pourcel also combats the assertion of M. Gruner, who asserts that iron phosphide will not scorify until the carbon is reduced to the minimum. "How is it," asks M. Pourcel, "that Mr. I. Lowthian Bell, at the Clarence Works, and Dr. Bender, at Krupp's Works, succeed in dephosphorising their crude iron without diminishing the carbon contained in it? It is only necessary to quote the numerous analyses which prove that phosphorus disappears in direct proportion with the silicium." We learn, also, that Dr. Bender has adopted the Bell system at Essen, using a Pernot-Martin furnace, with iron sole and sides lined with rich manganiferous oxides. For several other interesting questions discussed by M. Pourcel we must refer the reader to his Paper.

The prime conclusion which M. Pourcel draws from his investigations is that the dephosphorisation of iron in the converter is an accomplished fact, and that the practical difficulties in the way of its industrial application may be surmounted by an attentive examination of the chemical phenomena which occur during the various operations.

Harmozein: a New Chemical Round Game, with Instructions for Playing it. By T. H. Davis, formerly Assistant at the Royal College of Chemistry. Manchester: J. Woolley, Sons, and Co.

Harmozein, the name of which is presumably borrowed from the Greek *harmozo*, I sort, or arrange in order, is a new scientific round game, which bears the same relation to chemical science that the much vaunted German *Kriegs Spiel* does to military strategy. Harmozein must not be confounded with the numerous so-called instructive card games by which children are supposed to be deluded into the study of the 'ologies and 'ographies under the guise of innocent gambling. The instruction conveyed by these appliances generally consists in the acquirement of a mass of words, more or less hard; but any one who plays at Harmozein must first of all have a fair knowledge of the theory of atomic quantivalence, which he will most certainly increase in proportion as he gains skill in the game.

The game consists of some 250 cardboard discs or counters, upon one side of which a chemical symbol is printed, with the quantivalence marked in the usual way, $Cl_{I}O_{II}B_{III}$, &c., the other side being left blank. The pieces are spread on the table blank side uppermost, and the game may be played by any number of players, each of whom selects from 10 to 20 pieces. The object of the game is to get rid of as many pieces as possible, each player being allowed to put down a formula as well as to add to those already on the board. Let us suppose, for instance, that the first player puts down COO, the second player, always provided he has the counters, puts down NaH and O, thus forming the complete formula of hydric sodic carbonate. He may then put down a formula of his own, let us say KCl, which no one can add to, as the monad K satisfies the monad Cl. He thus gets rid of four counters, whereas the first player only got rid of three.

Mr. Davis's game is sufficiently ingenious and interesting, but it might be improved. One of its objects being to teach the quantivalence of the elements, it seems strange that the pieces should be inscribed with the figures denoting it on the face. The quantivalence marks ought merely to be on the back, where the player is not supposed to see them. On the pieces denoting certain elements, such as iron, there is only one quantivalence mark, VI., but what is to be done when iron is a dyad, for instance. It would have been as well if the pieces denoting what Dr. Frankland calls polyad elements had been marked with their several atomicities.

Mr. Davis's first attempt is worthy of all praise, but he himself will be the first to acknowledge that it is susceptible of improvement. We have privately heard that it has received the warm approbation of one of the most highly placed chemical teachers in this country, who has recommended it to his students, a piece of advice which we most cordially endorse. Metz, it is said, was taken by efficient Kriegs Spielers: we shall be glad to see some correspondingly strong chemical fortress reduced by Harmozein players.

CORRESPONDENCE.

CLEMENTS' MANUAL OF ORGANIC CHEMISTRY.

To the Editor of the Chemical News.

SIR,—In a review of my book in your valuable journal of the 20th inst. several misstatements are made which I hope you will allow me to call attention to. Your reviewer states in the 31st line from foot of page 275 that no explanation is given of isomerism and polymerism. For *isomerism* please refer to pages 29, 47, 248, 254, 257, and 262, and for polymerism refer to page 262. Surely six or seven pages on this subject is sufficient in a work of less than 280 pages. In the line following it is stated that "no explanation is given of the difference between empirical and rational formulæ." Empirical formula is referred to on pages 3, 7, 9, 184, 192, 194, 196, 198, 202, and 223, and rational formula is referred to on pages 7, 8, 9, 10, 223, 229, and 254. I think in justice your reviewer should consider these references sufficient on this subject, considering that all students take up inorganic before organic chemistry, so that they would be well acquainted with the difference between rational and empirical formulæ. Moreover, page 223 alone should be sufficient to demonstrate to any student the essential difference between these formulæ. If the index is referred to, many of the other remarks will be found unnecessary, even including glycerin, &c. Furthermore, your reviewer states that "there is no evident distinction made between primary, secondary, and tertiary alcohols, nor between the different behaviour of aldehyds and ketons on oxidation." Pages 63 and 78 refer especially to the latter bodies, and the former is not borne out by the facts of the case. If your reviewer had thoroughly examined the book and referred to the index he might have omitted at least one-half of his review, which is both inaccurate and misleading.—I am, &c.,

HUGH CLEMENTS.

June 24, 1879.

Mr. Clements in his note says that "had the reviewer thoroughly examined the book and referred to the index he might have omitted at least one-half of his review." I beg to state that not only was the book thoroughly examined before the review was written, but after it was written the statements therein made were carefully compared with the index. I have looked up all the references he mentions in his letter, and find that, with two exceptions, they are quite irrelevant and frivolous. These two exceptions (pages 248 and 262), which refer to the explanation of isomerism and polymerism, though good explanations, are both given in the answers to the questions set by the Science and Art Department, and not in the *text* of the book itself, which is the point in question. In fact, the references which Mr. Clements gives are not to explanations of the terms in question, but merely references to the page where these terms are used; *e.g.*, reference to page 47 for explanation of isomerism, "When it is distilled with $CH_3.HSO_4$ methyl ether is formed, which is isomeric with ethyl alcohol." Also the reference to p. 184 for explanation of empirical formula—"What is the empirical formula of a substance possessing the following percentage composition:—$C=40{\cdot}0$, $H=6{\cdot}66$, $O=53{\cdot}34$. Dividing by the atomic weights of C, H, and O respectively, we obtain 3·33 for C, 6·66 for H, and 3·33 for O, and dividing by the smallest we get 1, 2, 1 respectively for C, H, and O, *i.e.*, the formula CH_2O. And the substance may therefore be $C_2H_4O_2$, acetic acid; $C_3H_6O_3$ lactic acid; $C_6H_{12}O_6$ grape-sugar." The references on pages 192, 194, 196, 198, 202, 223 are all of a kind exactly similar to the latter of the above two examples. The reference to page 254, as regards the explanation of rational formula, is "What is the rational formula of glycerine? $C_3H_5H_3O_3$." These are samples of the references which Mr. Clements gives for finding in his book explanations of rational and empirical formulæ, isomerism, &c. Mr. Clements does well to use in his letter the words "referred to" on such a page, for it is quite true the terms are there referred to, but this is no contradiction of the statements made in the review, where it is said that "No explanation is given of" the terms in question. He, in fact, *talks about* these terms, but gives no *explanation* of them. Page 223 is by no means an explanation, as Mr. Clements seems to think, of the terms rational and empirical formulæ, and even if it were it is not in the text of the book, but in the questions set by the Science and Art Department. With regard to glycerin, if Mr. Clements will again consult the review, he will find that the words "special reference" were used (and used advisedly) because though glycerin is often mentioned by name, yet no special statement is given (except in the case referred to in the review) of its general chemical reactions and relations to other compounds. On looking up the references on pages 63 and 78, as given by Mr. Clements, I cannot find that any evident distinction whatever is made between the behaviour of aldehyds and ketons on oxidation. As regards the statement in the review that no evident distinction is made between primary, secondary, and tertiary alcohols, which Mr. Clements says "is not borne out by the facts of the case," how is it that he does not give a reference showing where the distinction may be found? I observe that on page 246, in the answers to the questions set by the Science and Art Department, an "attempted" explanation is given, but this is not all clear, and I believe that the average student would quite fail to understand it. It would seem that for some of the more important parts of organic chemistry we must consult not the "Manual" itself but the answers to the questions at the end of the book.

The Reviewer.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 24, June 16, 1879.

Observations on M. Lamansky's Paper entitled "On the Law of Stokes."—E. Becquerel.—The phenomena of fluorescence do not depend on a simple change in the refrangibility of the luminous rays which fall upon a body, but on a complete transformation of the vibratory movement. The incident rays excite vibrations in the substance, which then emits light whose composition does not seem simply connected with the nature of the incident vibrations.

Vapour-density of the Bihydrosulphate of Ammonia.—H. Sainte-Claire Deville.—The author gives the details of his determination of the vapour-density of neutral ammonic sulph-hydrate, NH_4S, taken at the temperature 99·5°.

Electro-dilatation of the Coatings of Leyden Jars.—M. Duter.—The author has undertaken experiments which show that the cause of the expansion is not electric pressure, but that we have here to do with a new property of electricity.

Expansion of the Glass of Condensers while Charged.—M. Righi.—The phenomenon of Fontana, Govi, and Duter is due to a transverse expansion of the glass. The instantaneous expansion, due chiefly to the polarisation of the glass, must be distinguished from the persistent expansion not previously observed and due to a liberation of heat.

The Basic Hydrosulphates of Ammonia.—M. L. Troost.—The author has obtained several compounds of hydrosulphuric acid with ammonia. One of them at 0° occurs in ortho-rhombic crystals which act powerfully upon polarised light, upon which the ordinary crystals of bihydrosulphate have no action. A second solidifies at −8°, but may be maintained in a state of superfusion down to about −25°. The third has not been solidified at −55°. The author is engaged with their perfect separation and the determination of their vapour-tensions.

A New Native Manganese Sulphate and a New Variety of Ferrous Sulphate.—A. Carnot.—The new manganese sulphate, Mallardite, contains 7 molecules of water, and was obtained from the Lucky Boy Silver-mine, near the Butterfield Canon, Utah. The other mineral, luckite, is a manganiferous ferrous sulphate from the same deposits.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 1, 1879.

On Betulin.—N. Franchimont.—The author gives an account of the researches of H. Wigman. He assigns to betulin the formula $C_{36}H_{60}O_3$, but has not succeeded in ascertaining its nature, which, on the one hand, appears analogous to the terpenes, and, on the other, to certain aromatic hydrocarbons of high molecular weight.

On Lactucon.—N. Franchimont.—This compound, $C_{14}H_{24}O$, is obtained from *Lactua altissima*, and appears a homologue of camphor and of the zeorin of Paterno.

Acetate of Zinc.—N. Franchimont.—The crystalline acetate, contrary to the statements of most writers, contains only two molecules of water.

Colouring Matter of Santal and Calliatura Wood.—N. Franchimont.—The colouring matter of these dye-woods is identical, and may be represented by the formula $C_{17}H_{16}O_6$. Calliatura wood is the richer in this compound. The pure colour, on fusion with caustic potash, yielded acetic acid, resorcin, and probably proto-catechuic acid, and pyro-catechin.

Influence of the Chemical Composition of Water in the Preparation of Raw Silk.—Communicated by the Instituto Technico Superiore of Milan.—In silk are distinguished the soluble constituents, "varnish," or "gum" and colouring matters, and, on the other hand, the insoluble fibre. The soluble constituents give raw silk its brightness, colour, and strength, and should therefore be preserved as far as possible. For the purpose of unwinding the cocoons the natural gum should be softened, but not dissolved. According to Franceson, silk, if deprived of all its soluble constituents, loses at the same time its strength and elasticity. The authors find that though the loss of strength is proportional to the loss of soluble matter the elasticity is but slightly diminished. In order to minimise the loss sustained in softening the cocoons hard waters are used, and soft waters are artificially modified by the addition of sulphate of lime and carbonate of soda. Silks which are to be dyed bright colours, however, should be spun out of soft water.

Action of Mono- and Diphenylarsinic Acid upon the Animal Organism.—H. Schulz.—Both these substances are poisonous and agree in their action with ordinary arsenical compounds.

Action of Cacodylic Acid (Dimethylarsinic) upon the Animal Organism.—H. Schulz.—According to the experiments of Bunsen, Kürschner, and others, cacodylic acid has been regarded as not poisonous. The author, on careful experimentation with a pure sample freed from arsenic penta- and trioxide by repeated recrystallisation out of absolute alcohol, found it poisonous, the usual symptoms being produced in the subjects.

Action of Hydrocyanic Acid upon Epichlorhydrin.—J. v. Hörmann.—The product of the reaction is chlorhydroxybutyric acid.

Succinyl Compounds of the Toluydins.—G. v. Bechi.—In this preliminary communication the author describes toluyl-succinimid, $C_{11}H_{11}O_2N$, obtained by heating together equal mols. of succinic acid and ortho-toluydin.

Schützenberger's Acetates of Chlorine and Iodine.—B. Aronheim.—The author considers it doubtful whether these products are definite compounds or mere mixtures.

Action of Nitrous Acid upon Resorcin Ether.—B. Aronheim.—The result is an acid ethyl-ether of mono-nitro-resorcin.

On Digallic Acid.—H. Schiff.—A controversial paper, having reference to Freda's memoir (xi., 2033).

Certain Derivatives of the Hydroquinons.—R. Nietzki.—The author describes his researches on mono-nitro-diethyl-hydroquinon.

Reply to H. O. Hesse.—C. Rice.—A. controversial paper on the quinon-alkaloids (xi., 1549).

Certain Species of Sugar.—M. Hönig and M. Rosenfeld.—A preliminary communication on the sodium compounds of fructose and lactose.

On Para-phenylen-diamin.—A. Krause.—The author describes here the action of chloride of lime in solution upon para-phenylen-diamin hydrochlorate, the behaviour of aqueous hydrochloric acid with the chlorine product $C_6H_4Cl_2N_2$, bichlor-bibrom-quinon, and monochlor-monobrom-anilic acid.

Behaviour of Alkaline Solutions of Alumina with Sulphuretted Hydrogen.—G. Lösekann.—These solutions, on saturation with hydrogen sulphide, deposit all their alumina as hydrate, which, when washed, dissolves in acids without evolution of hydrogen sulphide. No alumina can be detected in the solution. Alkaline solutions of chrome behave in a similar manner.

Splitting-up of Bichlor-acrylic Acid by Alkalies.—O. Wallach and O. Bischof.—A detailed examination of the reaction by which chlor-acetylen is produced out of bichlor-acrylic acid.

Reactions of Silver Ultramarin.—K. Heumann.—Two atoms of the silver are combined in a different manner from the third and are more readily substituted by sodium. That atom of silver which on the decomposition of silver-ultramarin by acids is separated out in combination with sulphur is not removed by the action of sodium chloride, but retains its place in the molecule.

Relative Affinity of Oxygen for Hydrogen and Carbonic Oxide.—A. Horstmann.—If carbonic acid is added in varying proportions to mixtures of hydrogen and carbonic oxide with insufficient oxygen, less of the carbonic acid and more of the hydrogen will be burnt than in parallel experiments without carbonic acid.

Eikosylen, a Derivative of the Paraffin of Lignite.—E. Lippmann and J. Hawliczek.—Eikosylen is homologous with cetylen and must be regarded as a high member of the acetylen series.

On Amyliden-anilin.—E. Lippmann and W. Strecker.—This compound is the first instance of a new series of tertiary bases, where in an amine molecule the aldehyd residue takes the place of both H.

Nitrocuminol and its Derivatives.—E. Lippmann and W. Strecker.—An examination of nitrocuminol, nitrocuminic acid, and amido-cuminic acid.

Compounds of Cobalt and Nickel Chloride with Tar Bases.—E. Lippmann and G. Vortmann.—This paper does not admit of useful abstraction.

Researches on the Bessemer Process (III. The German Bessemer Process).—F. C. G. Müller.—In the German modification of the Bessemer process the initial temperature is 1400°, as against 1200° in the original English process. Manganese, if exceeding 2·5 per cent, has an unfavourable influence on the working of the German process, and all well-managed works endeavour to keep its quantity below 2 per cent.

Gases Occluded in Iron and Steel.—F. C. G. Müller.—The respective proportions of the gases present in Bessemer steel before and after the addition of the charge of spiegeleisen and in Martin steel are:—

H	88·8	77·0	67·8
N	10·5	22·9	30·8
CO	0·7	—	2·2

Further Communications on the Formation of Xanthoid Bodies from Albumen.—H. Krause and G. Salomon.—The authors find that only the incipient stages of putrefaction are favourable to the formation of hypoxanthin.

Oxidation-products of Cinchonin.—W. Königs.—The author has examined the products obtained by distilling cinchonic acid with lime. Among the products obtained is oxy-cinchonic acid.

Constitution and Synthesis of Carbo-triphenyltriamin.—W. Weith.—This synthesis is effected from aniline and para-nitrobenzoic acid.

Formation of Hydro-cinnamic Acid during Pancreatic Digestion.—E. and H. Salkowski.—Hydrocinnamic (phenyl-propionic) acid is obtained during this process along with butyric and valerianic acids.

On Daphnetin.—Carl Stünkel.—The composition of pure daphnetin is $C_9H_6O_4$. Among its derivatives monoacetyl-daphnetin, tetra-brom-mono-acetyl-daphnetin, and mono-benzoyl-daphnetin are here analysed and described.

Ethers of Tribasic Formic Acid.—A. Deutsch.—An examination of ortho-formic ethyl-ether, with the corresponding methyl-propyl, iso-butyl, and iso-amyl compounds.

Contributions to the Volumic and Steric Laws. H. Schrœder.—This memoir gives the steres of the sodium, lithium, and calcium compounds.

MISCELLANEOUS.

Non-poisonous Character of Copper.—M. Galippe, in a paper read before the Biological Society of Paris, described the following experiment:—A rabbit received daily for six months 2 grammes (?) copper acetate. At the end of this time it was served up at the table of the learned chemist. The liver weighed 70 grms., and contained 13 centigrms. of copper. M. Galippe partook of it, and has suffered no inconvenience.

Chemical Society Research Fund.—The following grants have just been made from the Research Fund of the Chemical Society:—

£30 to Mr. W. Whiteley Williams, for experiments on an Improved Method of Organic Analysis.

£25 to Mr. M. M. Pattison Muir, of Caius College, Cambridge, for Determining the Physical Constants and Chemical Habitudes of certain Bismuth Compounds.

£15 to Mr. J. M. Thomson, for Experiments on the Action of Isomorphous Bodies in Exciting the Crystallisation of Supersaturated Solutions.

£50 to Dr. Wright, for continuing his Researches on Chemical Dynamics.

£25 to Mr. F. D. Brown, for continuing his Researches on the Theory of Fractional Distillation.

£30 to Mr. Bolas for an Investigation of certain Chromium Compounds.

£20 to Mr. F. R. Japp for an Investigation of the Action of Organo-zinc Compounds on Quinons.

£100 (the De la Rue donation) to Dr. H. E. Armstrong, for the Determination of certain Physical Properties especially Refraction Indices, of Typical Chemical Compounds.

The Treasurer, Dr. Russell, informs us that Dr. De la Rue has announced his intention of presenting the fund with £100; this will be the third donation of that amount which the fund has received from him.

NOTES AND QUERIES.

Tetrachloride of Carbon.—Will any of your readers kindly state the simplest and most practical mode of producing tetrachloride of carbon?—ClC.

Combustion of Magnesium.—If a small bundle of magnesium ribbon is burnt in a porcelain crucible, incomplete combustion ensues. If the ignited mass is then treated with HCl, H is evolved, and a series of small explosions takes place, the H taking fire. A fishy smell is at the same time evolved, rather like trimethylamin. Is the presence of a nitride sufficient to account for these phenomena? The porcelain crucible is slightly attacked, and a black insoluble stain left, which according to Gmelin is due to silicon.—S.

Erratum.—P. 260, col. 1, line 15 from top, for phosphoric read propionic.

A Chemist (21), who has had practical experience in works, desires Re-engagement. Good references; no objection to go abroad.—For particulars, &c., address, X. T., Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

A Chemist, who has had several years practical experience, is open to an Engagement. During the last six years has been engaged in the Alkali Manufacture.—Address, W. H. R., Fir Cottage, Weston, Runcorn.

Chemist, who has studied under the first Professors in England and Germany, and has had many years experience in theoretical and practical chemistry, and been in works, desires Re-engagement in Works or Laboratory, preferably in Brewery. Very highest testimonials and references.—Address, "Eosine," 3, Wimpole Street, Cavendish Square, W.

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Situation wanted, as Chemist or Assistant, by the Advertiser, who has had over seven years laboratory experience. Good references; salary moderate.—Address, No. 6024, Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, a German Chemist who has a practical knowledge of acetate soda making, and of the separation of arsenic from sulphuric acid.—"Civis," Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

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Proceedings of Societies.—Prof. Prestwich on the "Origin of the Parallel Roads of Lochaber"—Dr. B. W. Richardson on Hughes's New Instrument for the Measurement of Hearing, the Audiometer—Capt. Noble and Prof. Abel on Explosives (Fired Gunpowder)—Capt. Abney on the Production of Coloured Spectra by Light—W. Marriott on Thermometer Exposure—Prof. Hughes on his New Induction Balance.

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THE CHEMICAL NEWS.

Vol. XL. No. 1024.

A NEW APPLICATION OF RAPID OXIDATION BY WHICH SULPHIDES ARE UTILISED FOR FUEL.

By JOHN HOLLWAY.

[Mr. John Hollway has forwarded to us for publication the following account of his new application of rapid oxidation by which sulphides are utilised as fuel. Many who may not have read the longer account given in Mr. Hollway's paper read before the Society of Arts, February 12th, 1879, will probably be glad of this summarised account of the process.]

This process has for its object the utilisation of the heat generated by the rapid oxidation of certain mineral substances which have not hitherto been used as sources of heat for smelting operations. The heat thus obtained is employed in the reduction of the furnace charge, which may be composed partly of sulphides and partly of silicious ores. A current of air is forced through molten sulphides, by which means they are very rapidly oxidised. Great heat is thus developed, rendering the process of smelting a self-supporting operation; therefore no extraneous fuel is required, excepting that employed in raising steam for the blowing engines; where, however, water power is available, steam can be dispensed with, in which case all the carbonaceous fuel necessary for the operation is a little coke to start the furnaces, which stands in the same relative position to the ores as wood does to coal in the lighting of an ordinary fire.

It is well known that pyritous minerals are readily combustible, but the best means of utilising the heat-producing property of metallic sulphides is not so apparent as would at first sight appear. Of these sulphides only iron pyrites is sufficiently combustible at a low temperature to burn in the open air, the mass being raised to the temperature at which the oxidation takes place solely by the union of sulphur and iron with atmospheric oxygen. In Spain there are numerous deposits of poor cupreous pyrites, and the Rio Tinto and Tharsis Companies annually treat at their mines about one million tons for the extraction of copper only, which does not average 2 per cent. The process employed consists essentially in roasting the pyrites in heaps in the open air, dissolving out the copper from the roasted material, and precipitating it from the solution by means of iron. These operations extend over several months, any gold or silver contained in the ore is lost, and the iron and sulphur are also wasted. The sulphur passes into the air as an obnoxious and annoying gas, desolating the country for miles around the works.

From the earliest ages, carbon has been considered a necessity in all metallurgical operations. The first reduction of metals by means of carbon forms a connecting link between the age of stone and the commencement of civilised art. It is well known that carbon burns at widely varying temperatures, as, for example, in our bodies, in a common coal fire, or in a furnace. A great deal of thought has been devoted to the subject of economising carbonaceous fuel, and great advances have been made in this direction; yet the expenditure of coal or coke necessary, say to melt a given quantity of metal, still far exceeds the theoretical limit. The main causes of this discrepancy may be accounted for as follows:—

1st. Only part of the oxygen of the air passing into a furnace acts on the material to be burnt.

2nd. The oxygen is not brought in contact with the combustible matter with sufficient rapidity to obtain the necessary temperature for the operation.

3rd. Gases pass off hot and unburnt. These are now, however, frequently utilised.

There is one metallurgical operation in which the first two sources of loss are avoided, viz., "Bessemer's," where, by blowing air through molten crude iron, a very high temperature is attained by the combustion of small quantities of carbon and silicon contained in the crude iron; this is, however, not the case in the process of puddling, where the oxidation is spread over a considerable period of time, although the same constituents are frequently burnt in similar proportions. But even in the Bessemer process the carbon is only half burned, and a large amount of heat escapes with the carbonic oxide and nitrogen.

When, however, thin streams of air are forced through molten sulphide of iron lying on a tuyère hearth, a high temperature is produced by the perfect combustion which ensues in the midst of the sulphides, and no unburnt gases, excepting nitrogen and sulphur vapour, escape from the surface of the molten mass. The hot nitrogen and sulphurous acid may be caused to act upon iron pyrites and other mineral matter, and when pyrites is thus heated an atom of sulphur held in feeble combination is in great part expelled, and thus is obtained molten protosulphide of iron, which is subsequently burnt by the oxygen of the air driven in at the lower part of the furnace, thereby producing the heat necessary for continuing the operation. The process may be defined as a system of fractional oxidation, in which the numerous constituents of a complex furnace charge can be separated from each other and concentrated in different parts of the apparatus, the heat necessary for the operation being obtained by the combustion of a portion of the less valuable constituents.

The principal ores of all our ordinary heavy metals, except manganese and tin, are sulphides. Iron, although largely occurring in an oxidised form, is abundantly found in combination with sulphur; and bi-sulphide of iron, or iron pyrites, is an example of sulphurous and combustible minerals associated with the iron and sulphur; in iron pyrites are invariably found small quantities of other metals, notably cobalt, nickel, copper, silver, gold, lead, zinc, and arsenic. Of these zinc is almost as combustible as iron itself, while lead and arsenic readily volatilise as sulphides, and cobalt, nickel, and copper are distinctly less readily oxidisable than iron, while silver and gold do not oxidise under these conditions; hence, in supplying air to such material, the iron is the first of the elements to suffer oxidation, so that if the oxidation be arrested before the whole of the iron has been burnt, the cobalt, nickel, copper, silver and gold present will be found in the unburnt portion. This principle finds a parallel in the Bessemer process of treating pig-iron for the manufacture of steel, where a current of air is caused to bubble up through a bath of molten crude iron, the silicon is first oxidised, and is closely followed and to a great extent accompanied by the carbon, and no large amount of iron suffers oxidation until the whole of the silicon and carbon have been burnt out of the molten material.

The experiments made at Messrs. Cammell's works, at Penistone, in a Bessemer converter, have proved that by blowing air through molten sulphide of iron, the iron and a portion of the sulphur are oxidised, and if the oxidation is arrested before the combustion of the iron is complete a heavy matt or regulus is obtained, which contains but a small proportion of the iron of the ore, but practically the whole of the greater part of the copper and other less oxidisable metals. In one of these experiments the molten sulphides were run into the converter from a cupola, in which they had been previously melted, and the temperature was kept up until the operation was discontinued—viz., for a period of ten hours, without the use of any carbonaceous fuel, the heat being entirely derived from the oxidation of the iron and a portion of the sulphur of the lumps of pyrites, which were continuously thrown into the mouth of the converter. A Bessemer converter being unsuited for the collection of the gaseous products, the later experiments have been made in a series of cupola furnaces belonging to Messrs. John Brown and Company, Limited. These experiments have proved the possibility of obtaining a valuable regulus, a slag nearly free from copper, and a considerable quantity of crude sulphur. M. Pourcel, the well-known chemist of the Terrenoire Company, has also made some very interesting experiments, having treated by this method a cupriferous sulphide of antimony containing lead and zinc, using heavy spar and silica as fluxes; he obtained a regulus containing the whole of the copper in the form of sulphide, a slag of light specific gravity, and the lead, zinc, and antimony as two separate sublimates which were condensed in different parts of the apparatus, owing to the superior volatility of sulphide of lead over the oxides of antimony and zinc. In the experiments at Penistone and at Sheffield a cold blast of air was employed, and the gases which passed from the converter or furnace into the open air carried away with them a large amount of heat. In practice, however, it would be economical to employ a hot blast, which could be heated by the waste heat from the escaping gases. It is remarkable that the least valuable metals—viz., iron and zinc—generate by their combustion the largest quantities of heat.

The process may be employed for the reduction of even the more volatile metals; for example—Mr. A. H. Allen, of Sheffield, has thus obtained metallic antimony simply by the oxidation of sulphide of antimony. It is well known that sulphide of lead reacts upon oxide of lead with the production of metallic lead and sulphurous acid. If, therefore, a limited amount of air is blown into molten sulphide of lead, the oxide thus formed in the lower part of the furnace will, in passing upward, come in contact with the hot sulphide of lead, and metallic lead will result with the evolution of sulphurous acid. The furnace having a quiescent hearth below the tuyères, the metallic lead will collect there, and can be from time to time withdrawn. A limited amount of air must be employed, because if it is driven in too quickly, the sulphide of lead would rapidly distil off. In thus treating argentiferous lead ores, the silver (and gold if present) would be found with the first metallic lead reduced. When thus treating galena the furnace should have a basic lining.

The process is peculiarly suitable:—

1st. For the treatment of metalliferous substances which cannot be advantageously treated by other processes, For the extraction of sulphur by distillation, and simultaneously for the concentration and separation of cobalt, nickel, copper, silver, and gold from minerals in the form of metallic regulus, while lead, zinc, antimony, arsenic, &c., accrue in the sublimates.

2nd. For the treatment of complex ores, for example—Grey antimonial copper ores, such as those experimented on by M. Pourcel. Ores similar to those worked at the well-known Bottino Mines, Seravezza, in the Italian Apennines, which contain thirteen or fourteen heavy metals, including silver and lead, for which latter alone they have been worked for centuries. The blende of lead mines in Derbyshire termed "muck," usually thrown away by the miners, because the large quantity of lead with which it is associated renders the zinc obtained from it worthless.

3rd. For the treatment of auriferous and argentiferous pyrites. It is well known that in practice it is not possible to obtain the whole of the gold from pyrites by amalgamation with quicksilver, because the presence of sulphur and arsenic sickens and flours the mercury, whereas by fusion the whole of the silver and gold present is obtained.

4th. For the treatment of pyrites containing even only small percentages of cobalt, nickel, and copper, which are thus concentrated into a rich regulus, whereas this result is now only obtained by very tedious processes of alternate roasting and reduction. Such ores containing 10 per cent and even 12 per cent of copper exist in South America and many other parts of the world, but are not at present capable of economic treatment, owing to the difficulty of obtaining a sufficient supply of cheap fuel. The process can also be advantageously applied to the treatment of richer ores of copper such as are at present smelted at Swansea.

5th. For the treatment of poor lead ores. If such ores are added to a furnace charge of cupreous pyrites, the silica they contain will be utilised and combine with the resulting oxide of iron to form slag, the galena will be volatilised and be recovered as a sublimate, while any silver present will enrich the regulus. At present, by a costly process of crushing and washing these ores, the galena is concentrated, although a large proportion is left with the *débris*, and passes with the water into the streams, rendering the existence of fish in such waters impossible. The water power now used for washing the ore could, in many cases, be employed for producing the blast.

When thus treating cupriferous iron pyrites, four products are obtained:—

1st. A matt or regulus containing from 30 to 50 per cent of copper, any traces of cobalt, nickel, silver, or gold the ore may contain, the rest of it being iron and sulphur; it has a specific gravity of $4\frac{1}{2}$ to 5.

2nd. A slag consisting of silicate of iron from the resulting oxide of iron combined with the silicious matters contained in the ore and the fluxes added.

3rd. Sublimed sulphur, more or less mixed with volatile compounds of lead, zinc, and arsenic.

4th. Sulphurous gases, consisting mainly of sulphurous acid and nitrogen.

The regulus closely resembles, and will replace, the coarse metal of the Swansea copper process, which is now only obtained at considerable cost of labour, time, and carbonaceous fuel. When, however, sulphides of iron and copper present in the bath are treated continuously by a blast of air a point is at length arrived at when the whole of the iron is oxidised, and the regulus in the bath consists of sub-sulphide of copper. If, now, a limited supply of air is introduced, the copper is reduced to the metallic state with the evolution of sulphurous acid.

The slag obtained in the Penistone experiments was essentially silicate of iron containing about 50 per cent of iron and 29 per cent of silica. It had a density of about 3·8 to 4, and was in composition somewhat allied to the copper-smelters' ore furnace slag and to the tap-cinder of the iron-puddler. By the addition of calcareous materials the specific gravity of the slag is so reduced as to cause it to separate readily from the regulus which collects below it. In one of the later experiments, when lime was used, the proportion of copper lost in the slag was very small. This is, of course, a most important point, for when dealing with ores containing but little copper, the presence of even a small percentage in the slag means the loss of a considerable proportion of the copper present. These slags can be utilised for the manufacture of steel, being practically silicious iron ores free from phosphorus, and their reduction in a blast-furnace can be profitably effected, as the proportion of iron present is high as compared with the weight of the material: indeed, it may be possible to reduce them while in a molten state.

By re-subliming the crude sulphur, it can be freed from all impurities except arsenic, and at the works of Messrs. John Hutchinson and Co., Widnes, this is eliminated by means of polysulphide of calcium.

As a certain proportion of the sulphur of the minerals suffers combusion, the resulting sulphurous gases contain from 14 to 15 per cent of sulphurous acid, and hence the proportion of sulphurous acid to nitrogen is nearly identical with that of the gases produced by roasting pyrites in the kilns employed by vitriol manufacturers, and can therefore be used with equal advantage for the production of vitriol in leaden chambers. This appears to be the simplest solution of the great problem how to smelt copper without causing a nuisance to the surrounding neighbourhood, although a similar result might be obtained by collecting and liquefying the sulphurous acid.

The more incombustible materials it is found practicable to employ without too great a loss of temperature, the wider will become the application for the process; for there are many ores, including silicates and carbonates, containing metals in the form of oxides, which might be conveniently smelted by mixing them with a sufficient proportion of pyritous ores to effect their reduction; in fact, one of the chief practical questions connected with this process is how far it may be trusted to effect the smelting of ores or furnace-charges containing comparatively moderate proportions of sulphides. It is evident that it will almost entirely obviate the necessity for using carbonaceous fuel, at least as far as the production of a regulus is concerned, and consequently the localities in which smelting operations may be advantageously carried on are thus greatly multiplied. One of its chief merits is that it is equally applicable, with comparatively little extra cost in the working, to very poor and very rich ores; for however small the resulting regulus, it will contain nearly the whole of the cobalt, nickel, copper, silver, and gold present in the furnace-charge, while any lead, zinc, antimony, and arsenic will be obtained as sublimates.

RESEARCHES IN CHEMICAL EQUIVALENCE.[*]

Part III.[†] Nickelous and Cobaltous Sulphates.

By EDMUND J. MILLS, D.Sc., F.R.S., and J. J. SMITH.

Although the chemistry of nickel and cobalt is interesting from many points of view, it is more especially attractive from the probable isomerism of these metals. Their combining proportions, in fact, according to the most valuable evidence we possess,[‡] appear to be entirely the same. We, therefore, thought it very advisable to inquire on what terms they might prove to be mutually equivalent; and the particular equivalence we have examined has been equivalent precipitability of the sulphates, by sodic hydrate, from an aqueous solution.

I. *Preparation of the Salts.*

The pure cobaltous salt was prepared by converting some excellent commercial crystallised chloride into luteochloride, the process employed having been already described by one of us.[§] The luteochloride was purified by precipitation with hydric chloride, and the mixture of oxides it left behind on ignition was evaporated with redistilled hydric sulphate.

The pure nickelous salt was prepared from a sample of nickelous chloride which contained copper, lime, and iron, but no cobalt. The copper present was precipitated with hydric sulphide, and the nickel in the filtrate was precipitated by hydric oxalate, in an acid solution. The nickelous oxalate was washed thoroughly with dilute hydric nitrate, ignited, and the oxide so formed heated with pure hydric sulphate, and so converted into sulphate.

II. *Method of Separating Nickel from Cobalt.*

We had next to select a method for the quantitative separation of nickel from cobalt. The first to which we had recourse was Liebig's,[||] which consists in adding hydric cyanide and potash to the mixed saline solutions, thereby forming nickelopotassic cyanide and potassic cobalticyanide: these new compounds are boiled with freshly precipitated mercuric oxide, which throws down the nickel as oxide and cyanide. The cobalt in the filtrate is then precipitated as mercurous cobalticyanide. On the ignition of these precipitates, nickelous oxide and cobaltic oxide are respectively left behind. We converted the oxides into sulphates and weighed them as such. (Throughout the whole of these experiment the nickel and cobalt were always weighed as sulphates.) We found, however, that after the expulsion, by ignition, of the mercury in the precipitates, the oxides were left in so dense and compact a state that it was only with the greatest difficulty that they could be converted into sulphates. To remedy this a weighed quantity of pure baric sulphate was added to the liquid before precipitation; the precipitate, becoming mixed with the baric sulphate, was thus spread over a large surface, so that the oxide was obtained in a finely divided state, and easily converted into sulphate.

In the experiments with this process, the nickel was invariably found too high. This was at first thought to be due to alkali which might cling to the precipitated oxide; and, on testing, some potash was actually found in the precipitate, which had been thoroughly washed. To remove this source of error the nickelous sulphate, instead of being weighed as such, was dissolved in water, excess of ammonia added, and the nickel deposited on a platinum crucible by means of two Grove's cells.

But the nickel was, with this method, still found too high, and we then thought that the separation had not been perfect. On testing the deposit, a considerable amount of cobalt was, in fact, found in it, and the operation required to be repeated three times before the separation was complete.

The next process we tried was devised by Rose.[*] It consists in saturating with chlorine a very dilute solution of the mixed salts, adding baric carbonate in excess, and allowing to stand from twelve to eighteen hours, with occasional shaking. The cobalt then falls as sesquioxide, the nickel remaining in solution.

But the results obtained by this method, as was also the case with Henry's modification of it (which consists in substituting bromine for chlorine) were very variable. In the former case the cobalt was generally found too low, even after standing over eighteen hours; the result appearing to depend a good deal on the liquid being shaken up at regular intervals, which cannot be very conveniently done during an entire period of eighteen hours. In the latter case the cobalt was generally found too high, nickel being precipitated along with it.

The last method tried, and the one finally adopted, is due to Gibbs.[†] In this the neutral solution of the sulphates is boiled with plumbic peroxide. The cobalt is then precipitated as a higher oxide, while the nickel remains in solution, along with a small quantity of lead. (The author of this process does not claim very great accuracy for it, but we have found it to be of adequate accuracy.

The manner in which we operated was as follows;— The perfectly neutral solution of the mixed sulphates was boiled for half an hour with plumbic peroxide, about 7 grms. of the peroxide being taken to 1 grm. of cobaltous sulphate, and the volume of the liquid being about 100 cub. centims. The liquid was then filtered, and the filtrate evaporated to about 20 cub. centims. Some aqueous hydric sulphide was then added, and the small quantity of plumbic sulphide formed filtered off. The solution of nickelous sulphate was then evaporated to dryness in a weighed crucible, ignited, treated with a little hydric sulphate, heated to very dull redness, and weighed. The precipitate containing the cobalt, with excess of plumbic peroxide and some sulphate, was boiled with hydric chloride until dissolved. Water was then added, and the lead precipitated with hydric sulphate and alcohol. The filtrate from the plumbic sulphate was then evaporated to dryness, heated till the excess of hydric sulphate was

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[*] A Paper read before the Royal Society, June 19, 1879.

[†] For Part II, see *Proceedings of the Royal Society*, vol. xxviii., p. 270.

[‡] Russell, *Journal of the Chemical Society* (1869), p. 294.

[§] *Philosophical Magazine* (4), xxxv., p. 245.

[||] *Ann. Ch. Pharm.*, lxv., 244.

[*] *Pogg. Ann.*, lxxi., 545.

[†] *Sill. Am. J.*, xiv., 205.

Nickelous salt taken.	Cobaltous salt taken.	Cobaltous salt taken (corrd.)	Total precipitate.	Nickelous salt precipitated.	Cobaltous salt precipitated.	Cobaltous salt precipitated (corrd).	Sodic sulphate precipitated.	Temperatures.	Number of experiment.
grm.	grm.	grm.	grm.	grm.	grm.	grm.	grm.	Degrees.	
0·1	0·9	0·8093	0·9155	0·1050	0·8105	0·7198	0·0105	7—8	I.
0·2	0·8	0·7581	0·8667	0·1980	0·6687	0·6268	0·0110	6—7	II.
0·3	0·7	0·6268	0·8980	0·2765	0·6215	0·5483	0·0135	7—8	III.
0·4	0·6	0·5598	0·8650	0·3510	0·5140	0·4738	0·0105	7—8	IV.
0·5	0·5	0·4363	0·8885	0·4465	0·4420	0·3783	0·0090	7—8	V.
0·6	0·4	0·3613	0·8635	0·5295	0·3340	0·2953	0·0150	7—7·5	VI.
0·7	0·3	0·2808	0·8440	0·5825	0·2615	0·2423	0·0110	7—7·5	VII.
0·8	0·2	0·1408	0·8840	0·7080	0·1760	0·1168	0·0130	8—8·5	VIII.
0·9	0·1	0·0483	0·8765	0·7865	0·0900	0·0383	0·0105	7—7·5	IX.

driven off, and dissolved in weter. A little hydric sulphide was then added, to remove a small quantity of lead still present, the filtrate evaporated to dryness, and the cobaltous sulphate weighed. The plumbic peroxide must, of course, be perfectly pure, because any impurity in it finds its way into the cobalt, and consequently makes that result too high.

In an experiment with this process 0·2500 grm. of cobaltous sulphate and 0·2500 grm. nickelous sulphate were taken, and the quantities found after the separation were ·2505 grm. cobaltous sulphate and 0·2490 grm. nickelous sulphate. The estimation of the cobalt is rather a troublesome and tedious process; but when the mixture of nickel and cobalt can be weighed, and the nickel in it estimated, the cobalt being taken by difference, this is an admirable method to employ. The following are some results of the estimation of the nickel in a mixture of 0·2500 grm. of cobaltous sulphate and 0·2500 grm. of nickelous sulphate:—

	Nickelous sulphate taken.	Found.
(1.)	0·2500	·2480
(2.)	,,	·2505
(3.)	,,	·2490
(4.)	,,	·2495
(5.)	,,	·2480
	Mean	·2490

Probable error of a single determination 0·16 per cent.

III. *Experiments on Equivalence.*

Having then fixed on the method of separation, 1 per cent solution of nickelous and cobaltous sulphates were prepared, and a solution of sodic hydrate, of which 10 cub. centims. were capable of precipitating 0·8248 grm. of nickelous or cobaltous sulphate. This sodic hydrate was made from sodium, and kept in glass bottles coated internally with a thick layer of paraffin.

A series of nine experiments was made, in which the relative weights of nickelous or cobaltous sulphate present varied from 0·1 to 0·9 grm.; the total weight of nickelous and cobaltous salt, and the volume of the solution being, however, always the same—viz., 1 grm. and 100 cub. centims. The experiments were conducted as follows:—The bottles containing the solutions of the sulphates and the sodic hydrate were immersed in a trough into which there was a constant flow of water to bring them to a constant temperature. The necessary quantities of nickelous and cobaltous solutions were then carefully measured out, mixed, and the temperature observed. 10 cub. centims. of sodic hydrate were then added, the solution stirred vigorously, and the temperature again observed. The precipitate was then filtered off as quickly as possible (an aspirator being used to facilitate the filtration), and washed, first with cold and then wiih hot water. Three days' intermittent washing was required to free the precipitate from the undecomposed nickelous and cobaltous salts, cobaltous hydrate having, as is well known, a powerful attraction for cobaltous sulphate, thereby forming a basic salt. After washing, the precipitate was converted into sulphate by treatment with hydric sulphate, and weighed. The mixed sulphates were then dissolved in water, and separated by Gibbs's method, the nickelous sulphate being weighed, and the cobaltous sulphate obtained by difference. It was found that a small quantity of sodic sulphate was always present in the precipitate, the washing having failed to remove it, and this required to be estimated and deducted. For this purpose the nickelous sulphate, after being weighed, was dissolved in water, and the nickel precipitated with baric hydrate. The barium in the filtrate was then removed with hydric sulphate, and the filtrate containing the sodic sulphate evaporated to dryness and weighed. The results obtained are comprised in the table at top of page.

In this table the precipitates are all returned as sulphates. The total possible amount of normal sulphate attainable with the constant quantity of sodic hydrate employed having been 0·8248 grm., we are able to calculate the entire composition of the precipitate thus:—From its total weight, the amount of sodic sulphate is first subtracted; from the residue the constant quantity 0·8248; the remainder, which is the cobaltous sulphate carried down with the hydrate, is deducted as a correction from the cobaltous sulphate originally taken and that which was precipitated, it having no share in the reaction we had to examine. Under "temperature" we give the temperatures of the reagents before and after mixture. The weight of precipitated sodic sulphate varies but little throughout the experiments, its mean value being 0·0115 grm. In a special determination, we precipitated, with the usual amount of sodic hydrate, 1·000 grm. of nickelous sulphate alone: after three days' washing, it was found to contain 0·0115 grm. of sodic sulphate. Hence we infer that when the two sulphates are present together, nickelous hydrate carries down sodic sulphate, cobaltous hydrate carrying down cobaltous sulphate.

IV. *Discussion.*

In the following discussion it will be understood that we refer to the tabular results already given.

If n represent a weight of nickelous sulphate taken, and ν be the hydrate (calculated to sulphate) obtained from it through precipitation, then we consider ϕ in the expression $n=\phi\nu$ to represent the *precipitability* of nickelous sulphate: and similarly in $c=\phi\gamma$, ϕ represents the precipitability of cobaltous sulphate. In examining the numbers obtained with the nickelous salt, the best expression we could find for ϕ was $\phi=(\alpha+\beta n)$. We first calculated the values of α and βn from all the determinations, and by the method of least squares, thus obtaining—

$$\phi=0{\cdot}98891+0{\cdot}22571n.$$

It is, however, clear that α cannot be less than unity; moreover, the first weight of nickelous precipitate is somewhat higher than is possible, and we have thought well to reject it. With these amendments we finally obtain—

$$\phi=1+0{\cdot}21940n,$$

with a probable error of 0·02558 for a single determination, or 0·00904 for eight determinations. Hence we infer that the *precipitability of nickelous sulphate is directly proportional to its mass.*

In the case of cobaltous sulphate, on the other hand, no such law holds good. After a very careful examination of the numbers, we could not find any satisfactory evidence of a change in precipitability with its mass, and consequently represent ϕ as a constant. The mean value of ϕ is in this case 1·1845, with a probable error of 0·02792 on a single determination, or 0·00931 for nine determinations. Thus ϕ is about equally well ascertained in both cases.

Our two equations may now be written—

$$\left.\begin{aligned} n &= (+0{\cdot}21940n)\nu \\ c &= 1{\cdot}1845\gamma \end{aligned}\right\}$$

In order to calculate in what proportions the two sulphates are equally precipitable, we have—

$$1+0{\cdot}21940n=1{\cdot}1845,$$

whence $n=0{\cdot}84093$. The two sulphates, then, are equally precipitable when the weight taken of each is 0·84093 grm.

To calculate in what proportions the two sulphates must be mixed, to give equal weights of precipitate, we have—

$$\left.\begin{aligned} \frac{n}{c} &= \frac{(1+0{\cdot}21940n)\nu}{1{\cdot}1845\gamma} \\ n &= 1-c \end{aligned}\right\}$$

If we put $\frac{\nu}{\gamma}=1$, and combine these equations, the result is a quadratic, one of whose solutions is $c=0{\cdot}5168$, and consequently $n=0{\cdot}4832$. Using these values in the primitive equations, the results are, $\gamma=0{\cdot}4363$, $\nu=0{\cdot}4369$, which we may regard as substantially equal.

A highly important chemical relation is disclosed when the two sulphates are so conditioned as to be equally precipitable. We have seen that this is the case when $n=c=0{\cdot}84093$. Now the reciprocal of 0·84093 is 1·1892, a number differing by only the small amount of 0·40 per cent from 1·1845, or $\phi\gamma$. Deduced, as these values both are, from a series of experiments, we cannot hold their connection to be accidental. It may be thus expressed in symbols—

$$n=\frac{1}{\phi\gamma}=\frac{\gamma}{c}$$

or we may state the relation thus :—*For an equal weight, nickelous and cobaltous sulphates are equally precipitable ; the attraction of the one towards the reagent being then inverse to that of the other.*

In order to ascertain whether this function admits of extension to other weights than 0·84093 grm. of the sulphates, we doubled all the masses in one of our previous experiments (V. in the table), and determined the chemical effect. The results were—

Uncorrected total precipitate	1·7840 grm. 0·8925 ,,
Containing of nickelous sulphate ..	
The halves of these are	0·8920 ,, 0·4463 ,,
Figures nearly identical with	0·8975 ,, 0·4465 ,,

derived from Experiment V. By doubling the mass, we thus produce double the chemical effect. It is probable that this law is general ; and, therefore, we infer that the reciprocal function we have noticed may apply to multiples of the weights to which, in our particular case, it specially appertained. Bearing in mind that—

$$NiSO_4=CoSO_4=154{\cdot}65,$$

we accordingly write the function thus—

$$\phi(NiSO_4)=\phi^{-1}(CoSO_4).$$

If we imagine some reaction—such, for example, as the combination of colouring matter with a tissue—influenced in one set of experiments by nickelous sulphate, and in an altogether different set by an equal weight of cobaltous sulphate, we can hardly conceive any ground for the development of a reciprocal function, such as we have experimentally traced. On the other hand, it seems reasonable to suppose that when two bodies are simultaneously confronted with a single reagent, they both contend for its effect. Thus a chemical antagonism may arise between them by virtue merely of their being together ; and thence the reciprocal function. So far as we are aware, the only other chemical function of the kind hitherto investigated is to be found in Chizynski's* examination of the partial precipitation, by ammonic phosphate, of mixed calcic and magnesic chlorides. That chemist arrived at the conclusion, for which we consider his evidence to be adequate, that "equal masses of calcic and magnesic chlorides have always equal, but oppositely active, coefficients of affinity."

ON THE TOTAL ESTIMATION OF NITROGEN BY COMBUSTION, INCLUDING THE NITRO-COMPOUNDS.

By JOHN RUFFLE, M.R.A.C., &c.

In a previous note on this subject (Chemical News, vol. xxv., page 189) I stated that by modifying the well-known soda-lime process for a nitrogen determination by combustion, as much as 80 per cent of the nitrogen of a nitrate could be determined whether present in conjunction with ammoniacal salts or otherwise, and that under certain circumstances as much as 94 per cent of the nitrogen of a nitrate had been converted into ammonia in such combustion process. Also in the note I recognised the value of a ready method for the complete determination of the total nitrogen in a substance. During the seven years which have elapsed since the appearance of my note a great part of my leisure time has been spent in conducting experiments on this subject, and I at length have the great pleasure of reporting the following satisfactory results :—

Substance taken.	Percentage of Nitrogen by Theory.	Percentage found.
Soda nitrate—$Na_2ON_2O_5$	16·47	16·43
,, ,, ...	,,	16·32
,, ,, ...	,,	16·26
,, ,, ...	,,	16·56
Potash nitrate—$K_2ON_2O_5$	13·90	13·94
Lead nitrate—$Pb_2ON_2O_5$	8·45	8·21
Am. nitrate—$(NH_3)_2N_2O_5H_2O$ ..	35·00	35·04
Quin. slph. $2C_{20}H_{24}N_2O_2.H_2SO_4$ 7 aqua	6·41	6.30
Common pyroxiline used for collodion—$C_{18}H_{22}O_{15}(NO_2)_7$ (?)	(?)	11·64
,, ,, ,, ,,	(?)	11·41
Powder from a Snider cartridge containing 75 per cent potash nitrate (?)	10·35 (?)	10·10
,, ,, ,, ,, ,,	,,	10·12
An artificial manure containing superphosphate and nitrate soda 25 per cent=nitrogen—4·11 ; sulphate ammonia 25 per cent=nitrogen—5·30 ..	9·41	9·28
,, ,, ,, ,, ..	,,	9·33
An artificial manure containing superphosphate and nitrate soda 25 per cent=nitrogen ..	4·11	4·24
,, ,, ,, ,, ..	,,	4·23
An artificial manure containing superphosphate and nitrate of ammonia 25 per cent=nitrogen	8·75	8·81
,, ,, ,, ,, ,,	,,	8·92
A mixture containing, per cent— Suprphosphte. 70 Hair .. .. 10=nitrogen 1·46 Sulph. amm. 10= ,, 2·12 Nitrate soda 10= ,, 1·64	5·22	4·99

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* *Ann. Ch. Pharm.*, Supp. iv., 226 to 253.

It will be seen that the above results give the nitrogen when present as a simple nitrate, or as a lower oxide of nitrogen, also when the nitrate is mixed in a complex substance like an artificial manure or gunpowder, and whether with or without the presence of organic matter. From these and other results the process employed will, I believe, through conversion of the nitrogen into ammonia by combustion, enable the ready and complete estimation of the total nitrogen in a compound or mixture in whatever form the nitrogen may be present—*i.e.*, as an albuminous compound, ammoniacal salt, or as an oxide of nitrogen.

When I have concluded the experiments in hand, and have been able to tabulate my results, I shall make known the method.

Laboratory, Upton Manor, Plaistow, E.
July 1, 1879.

PREPARATION OF AMMONIA-FREE DISTILLED WATER.

By J. S. THOMSON.

The method of water analysis as elaborated by Messrs. Wanklyn and Chapman leaves but little to be desired in the matter of simplicity. The only part of the process which is in any degree tedious is the preparation of the ammonia-free water. That such is the case is, I think, clearly shown by the number of suggestions which have from time to time been made with the object of either doing away with distillation in its preparation altogether or of at least securing a larger proportion of the distillate fit for use in the process of analysis than is usually the case. These various processes, although no doubt very ingenious, have never come into general use, chemists still preferring to prepare the water by the original progress, tedious though it be. The process about to be described appears to be free from the objections commonly urged against the earlier ones, and at the same time it has the advantage that the original cost of the necessary apparatus is but small.

The following modification of the distilling apparatus commonly found in laboratories at once provides a simple means of securing a practically unlimited supply of ammonia-free water and at the same time demands little or no attention. The tube which conducts the water vapour from the still or boiler in place of being connected directly with the worm or condenser pipe, is made to enter at the bottom of a large iron drum (say 10 gallons), while the top of the drum is connected with the worm pipe in the ordinary manner. The drum, which is freely exposed to the atmosphere, condenses a portion of the aqueous vapour, which, falling to the bottom, is kept in a state of ebullition by the free steam blowing through it. Now, if this be drawn off by a suitable tap it will be found to be perfectly free from ammonia, while the ordinary distilled water got at the worm end is teeming with ammonia. With apparatus of the dimensions given above, with a plentiful supply of steam, the ammonia-free water can be collected at the rate of about one gallon per hour.

Addiewell Chemical Works,
June 30, 1879.

NATURE OF COHESION AND ITS CHEMICAL SIGNIFICANCE.

By FRIED. MOHR.

Amongst all the properties of matter cohesion is the most universal in its manifestations and yet the least regarded. We are so accustomed to perceive all things in a certain state of cohesion, that we cannot separate this attribute from the essence of things, whence it happens that it has been treated as the Cinderella of physics and seems as it were placed outside the law of the conservation of force. An attempt has been made to explain the phenomenon by means of the attraction of the smallest particles, and to bring this attraction into connection with the universal attraction of the heavenly bodies, which is also merely an assumption. It is plain that cohesion is a true force which can be measured by the sum total of force required to overcome it. We must endeavour to bring this cohesive force in connection with the other accessible and known forces according to the laws of mechanics. The force most readily to be connected with cohesion is heat, because we know that heat can overcome cohesion. We must seek to understand how heat—which we rightly consider as an internal movement in substances—exists in such substances, and for this purpose the theory of waves offers us the needful points of approach.

After summarising the characteristics of undulation, and distinguishing progressive and stationary waves, the author proceeds:—

Cohesion is not due to thermic vibrations, as, on the contrary, heat annuls cohesion. A second force must therefore be present which produces the phenomena of cohesion. Thermic vibration has merely served to explain the mechanism of internal motion.

The existence of a second force or movement present in all bodies, and essentially distinct from heat, is inferred from the heat which appears on chemical combination. We must always remember that force is never created or annihilated, but that in all cases there occurs merely a modification in the form of the movement, but not in the sum of the *vis viva*. If, therefore, heat appears in any chemical process, it must have been present in the reacting matter in some other form—as motion which is not heat. For storing up a great force in a small quantity of substance no other form can be found save that of stationary waves, which cannot become progressive; and in solids we assume a vibration much smaller than that of the heat waves as regards its volume, but much greater as regards the number of the waves. For this movement I proposed, in 1868, the name "chemical motion," or chemical wave.

We see everywhere that heat overcomes cohesion, and in so doing disappears as heat. This state has been termed latent heat, though we must remember that it is no longer heat, but a movement of another kind. If mechanical power is produced by heat, such heat likewise becomes latent, and the movement of masses, like the thermo-electric current, may be called latent heat.

A proof that a great sum of *vis viva* exists in bodies, in addition to heat, may be given experimentally by means of the calorimeter.

The author adduces experiments in proof of this proposition, and continues:—

Everywhere cohesion is modified by chemical processes, and inversely in every chemical process a change of cohesion appears.

After considering the action of cements, solders, and of the apposition of smooth clean homogeneous surfaces, Dr. Mohr continues:—

Between cohesion and adhesion there is no difference; cohesion was sometimes said to exist between similar and adhesion between dissimilar bodies. If a thick solution of glue is dried up in a porcelain capsule, pieces of the latter may be broken if the glue is removed forcibly. Here adhesion is stronger. Cohesion is a decidedly chemical property, and can be overcome by chemical means. Solution is the fusion of a solid body in one already melted. In the latter its peculiar molecular motion which determines its chemical attributes has been already overcome or modified by an excess of heat, a part of which has apparently disappeared as such, and has been converted into another form of movement. The excess of heat still suffices to overcome cohesion in another body, and thus again a certain quantity of heat disappears as such. Latent heat is not heat, but a new chemical attribute. The 79 heat-units which a weight-unit of hot water at 79° conveys suffice to overcome the cohesion of one weight-unit of ice at 0°, and to convert it into water at 0°, and as long as the water remains liquid no other free heat is present than that which belongs to it as water. But as soon as the water is made to freeze 2×79 heat-units escape, and there remain two weight-units of ice at 0°. This leads us directly to the connection between hardness and fusibility. The latter is decidedly a chemical attribute, and their connection secures the same rank for hardness. The metals form a scale of hardness almost in accord with their fusibility. The fats form two parallel scales of hardness and fusibility from white wax to oil of almonds.

It has been already shown that cohesion consists essentially in the perflux of the stationary waves of that movement which permanently determines the chemical attributes of bodies, and we distinguish the permanent non-communicable movements from the transient movements of free heat. Every permanent action of heat which reveals itself by a change of cohesion is attended by a permanent change of the chemical nature. [?]

Cohesion and affinity being closely connected we are led to consider more closely the views on affinity. The ordinary doctrine is that affinity exists only between bodies which are chemically different. This is correct if we rank among the manifestations of affinity merely such processes as are attended with explosion, ignition, or the production of a strong heat. But it seems that we might exactly invert this proposition, and, as in the animated world, assume affinity among like bodies, if we suppose that the mobility of matter depends on heat. Thus water unites with water in every proportion without any perceptible physical phenomena. But water with its 88·9 per cent of oxygen has no affinity for liquids poorest in oxygen, such as benzol and petroleum. Ethereal oils dissolve in water almost proportionally to their percentage of oxygen, and phenol is tolerably soluble. Potassic chloride and iodide, ammonic chloride, &c., dissolve in water, on account of the analogy between chlorine, iodine, and oxygen. Between water and fats there is not even adhesion or moistening. The internal movements are respectively so heterologous that the wave-systems cannot pass into each other; on the other hand, liquid oils adhere to solid fats, as does mercury to gold.

It was observed that certain chemical bodies can be mutually substituted for each other in crystals without a change of form. This fact was named isomorphism. When it subsequently appeared that the atomic volumes of isomorphous bodies was equal, the idea of isomorphism was transferred from the crystal to the atom, it being assumed that the substitution was explained by the equal size and similar shape of the atoms. Thus sulphur, selenium, chromium, and manganese appeared isomorphous on account of the acids RO_3, and manganese and chlorine on account of the acids R_2O_7. If isomorphism depends on the identical form of the atoms, chlorine must be isomorphous with sulphur, selenium, and chromium. This is not the case, and the assumption is therefore false. Sulphur has two crystalline forms differing in specific gravity, and consequently in atomic volume, which is atomistically impossible and unthinkable. The acicular sulphur when it passes into the rhombic form by comminution evolves heat, and on burning evolves 41 calories more than does the rhombic variety, so that this heat must have entered into crystallisation. The assumption of the equal shape and size of atoms is therefore untenable.

Our modern theoretical chemistry depends entirely upon the atomic hypothesis, *i.e.*, it is assumed that the elements consist of smallest particles not further divisible, and hence called atoms. On this point we have neither direct observations nor experiments. The assumption is made in order to explain the fact, a thousand-fold confirmed, that the elements always combine with each other in definite ponderable proportions, and that if two elements form several combinations, their proportions are small multiples, not exceeding the number 7. In fact the atomic theory explains this phenomenon satisfactorily, but nothing more, and great modesty has been shown in endowing these atoms with properties because important mechanical difficulties cropped up on all sides and weakened the indispensable proof for multiple proportions. We have no idea of the form, the colour, the magnitude of these atoms, and we have merely deduced their relative weight, their relative volume, and their specific heat. Our monistic conception of nature leads us to apply to atoms our view as to the cohesion of bodies, since the assumption of indivisibility must find its ultimate basis in cohesion only.

The magnitude of the atomic weights has been deduced from analyses, leaving merely the uncertainty whether a single or a double weight must be admitted, according as we proceed with or without Avogadro. The atomic volume equals the atomic weight divided by the specific gravity, and the atomic heat is the product of the specific heat and the atomic weight.

The calculations founded upon these propositions depend on the assumption that the specific gravity of the atom is the same as that of the mass. The discussions concerning atomic volumes are well known. According to the experience that the atomic weight of a compound may be found by adding up the atomic weights of its constituents, we might imagine that the atomic volume of a compound would be calculable in a similar manner. This, however, is never the case. The specific gravity of the individual constituents is never the same in the compound as in their free condition, but expansion or contraction always ensues. The compound never occupies the same space as its constituents. Carbonic bisulphide occupies 41 per cent more space than its constituents. Its specific gravity, calculated from that of carbon and sulphur, should be 2·152, but it is found to be only 1·272. Consequently atoms have to be credited with a power of expansion or contraction according to circumstances. The calculation of the atomic volume presupposes that the atom of silver possesses the specific gravity of a mass of silver (10·428). We must then also assume that it has the lustre and the opacity of massive silver, not to speak of hardness, because it is indivisible. If we once assume atoms we must grant them not merely indivisibility, but also immutability, and it is then inconceivable how we can see through melted nitrate of silver which contains by weight 63 per cent, and by volume 6 per cent, of metallic silver. The mercury atom must be a minutest granule of mercury, and equally opaque as mercury in bulk. Concerning carbonic acid and ether, we know that if heated in strong glass vessels they disappear, and yield a vapour almost of the same density as the liquids themselves. If we assume this to be the case with mercury, the absolutely transparent and invisible vapour of mercury would have nearly the specific gravity 13. This fact, and, indeed, the changes of all bodies by mere heat, is on the atomic theory incomprehensible. A different arrangement of the atoms cannot possibly deprive them of all their attributes.

The atomic theory meets with its greatest difficulties in the gases. It is necessarily assumed that the atoms of hydrogen, oxygen, &c., are solid, massive, indivisible bodies. The specific gravity of these atoms cannot be determined, since heat and pressure cannot be removed from them. Most of these gases are absolutely invisible, and according to the analogy of mercury and zinc, it would be possible that such atoms also may be of an opaque, metallic nature. But the liquefaction of the permanent gases, lately so-called, yields colourless liquids, which, indeed, like water, are invisible by transmitted light. The atomic theory is compelled to assume that the gases move as distinct particles in an absolute vacuum. But then we cannot understand how light can penetrate. The optical ether is no more a matter of demonstration than the atoms, and, as we deny its materiality, it cannot be the substratum of a force. The gas theory of König and Clausius is a rather bold attempt to explain the existence of gases; but it cannot maintain its ground even on mechanical principles. It is assumed that the absolutely elastic gas atoms move with equal speed in a rectilinear direction, and rebound from the sides of the vessel. At the same time they vibrate in all directions. It is mechanically inexplicable that a body moving in a certain direction should ever change its direction without some external influence. The individual atoms must share among themselves the function of vibrating in different directions.

If in a cubic metre of empty space there is one cubic millimetre of hydrogen gas, there must be spaces perfectly void. The nature of gases is inexplicable, unless we consider the matter of the gases as continuous and perfectly elastic, whereby the empty spaces are done away with. This applies to all bodies which can assume the gaseous state or can combine with solids according to the law of multiple proportions, *i.e.*, to all the elements without exception. The atomic theory fails to explain the changes produced in bodies by heat alone; the difference of properties in compounds and in their constituents; the liberation of heat which accompanies combination, and its disappearance during fusion and dissociation; it does not explain allotropisms, colours, states of cohesion; in a word, it explains nothing save the uncontested fact of combination in definite proportions.

Atoms which according to theory are solid bodies must have a shape. On this subject nothing has been observed. As the most natural conjecture the sphere has been assumed as the most regular of all forms. But in pursuance of another theory the existence of molecules has been inferred, *i.e.*, combinations of from two to six atoms forming one common body, and it is conjecture that the gases in a free condition consist, not of single atoms, but of molecules each formed of two atoms.

For this view we have no proof save its agreement with a hypothesis itself incapable of demonstration. It cannot be shown how the tendency of the individual atoms towards union can be satisfied by any particular number, since between two individual bodies, *ex hypothesi* absolutely identical, no compensation of different forms of motion can take place. We are unable to say whether a mass of silver or copper is composed of atoms or molecules. Two spheres can touch each other only at one point, and, as we have shown above, no notable cohesion can thus arise. The spheres have also been invested with absolute elasticity, without which the permanence of a gas cannot be thought. If we wish to assume that these spheres flatten each other, and thus offer a larger surface of contact, there can be no reason advanced why the atoms should press so closely together. A body consisting of spheres must necessarily contain empty spaces, into which the finer atoms of gases, such as hydrogen, may penetrate. But not a single fact supports this view (?); and we must, therefore, assume that massive bodies completely fill the space which they occupy.

The origin of a body continuously filling space, as the doctrine of atomic volumes demands, presupposes atoms as bounded by plane surfaces.

The strong cohesion of solids compels us to assume that their mass is continuous, and at the same time elastic, so as to receive the waves of thermic and cohesive movement. If we sum up in brief our results, they may be formulated as follows:—

1. Cohesion depends on pervading stationary waves of a particular form of motion, which at the same time determines the chemical properties of bodies. These waves are not directly transmissible.
2. Heat is another form of movement with both progressive and stationary waves, which can be communicated from one body to another.
3. In the chemical union of two bodies a part of the chemical movement is eliminated as heat, or heat is taken up as chemical movement. In the former case there is an increase of cohesion, and in the latter a decrease.
4. Heat is everywhere present in the free state, and everywhere it diminishes cohesion.
5. The quantity of *vis viva* which dwells in any substance as its chemical quality exceeds the free heat immensely.
6. Solids have unchangeable nodal planes and stationary semi-waves at their boundaries. Liquids have movable nodal planes.
7. Vapours are gases from which the chemical wave-movements are easily separated as heat. Gases are vapours from which these movements are not readily separable, the difference being merely one of degree.
8. All the phenomena of cohesion can be reduced to vibration.
9. Allotropic forms are distinguished by unequal quantities of chemical movement, and of the accompanying differences in cohesion, as proved by unequal heats of combustion.

The facts of definite proportions and of small multiples must find a new explanation, and if the suspicious word "atom" is to be avoided we may speak of combining weights. The law of Dulong and Petit of the equal atomic weights of the elements, though not thoroughly carried out, does not depend upon accident, and must have a real basis; likewise the fact of similar atomic volumes in bodies chemically similar. The further fact must be recognised that the gases combine in simple proportions, and that their combining weights coincide with their specific gravities. The magnitudes of our atomic weights will also not be influenced by a new theory.

The laws of wave-movement are the same for the revolution of worlds, for the waves of water, the pendulum, the vibrating string, for sound, light, heat, and cohesion.

As the phenomena of cohesion and the chemical properties of bodies therewith coincident depend on the transit of waves, the long-recognised fact becomes intelligible that chemical action ensues only on the immediate contact of the bodies, that the phenomena of affinity do not depend on a specific attraction, and that there can be no question of a static of atoms. Chemical combination is the act of assimilation of different systems of waves, and it is the more intense the more they differ in their qualities.

After chemical combination the two bodies interpenetrate each other completely, and possess one and the same wave-system, but different from the systems of their free condition.

As the colour and hardness of bodies are consequences of their inner wave movements the change in the properties of the new compound are easily explained by the elimination of movement in the shape of heat.

Dissociation is the rupture of a chemical compound by heat which is permanently introduced as chemical movement and becomes latent. One at least of the constituents must be gaseous or be capable of becoming so.

The explanation of definite combining proportions by means of the atomic theory was, further, very difficult, and was not reached without some *sacrificio dell' inteletto*, which, however, was overlooked, as the consehuences were not inferred. On attempting to bring cohesion within the law of the conservation of energy all this came to light, in addition to the inexpugnable mechanical difficulties which cling to the idea of the atom. Along with atoms must fall their enumeration, their catenation, their position, the molecules and their "splitting," the structural formulæ, the types, the rings, the unities of affinity, and the whole atomistic *cancan* as at present in vogue. Modern chemistry has placed herself outside the law of the conservation of energy; she accepts the heat of combination as a free gift without asking its origin; she explains the different properties of isomeric compounds by a different position of the atoms, though such compounds display different combustion-heats and from position alone no movement can arise. Lothar Meyer's ingenious syllabus of modern chemical theories begins with the sentence:—"The foundation of all at present prevailing chemical theories is the atomistic hypothesis," and the burning question of the combustion-heats is not noticed in a single syllable; not even the feeling of the need of an explanation of this the most important of chemical processes can be traced. If based upon a false foundation science can make no valid advances, and explanations turn now upon hypotheses rather than upon nature. In due time an explanation of the law of multiple proportions, based upon the theory of undulations, will be found, and instead of a proud *ignorabimus* we shall have modest *ignoramus*, or even a hopeful *inveniemus*.

The foregoing representation is indeed merely like a blow on water, which stirs up a few ripples, but no persistent ones. It is easier to agitate atoms than to shake the faith in them, and I hear many a voice exclaim, "Disturb not my structure formulæ; are all the time and labour expended in making them look like something real to be wasted? or can you give us a new faith in place of the old?"—*Annalen der Chemie.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

June 28th, 1879.

Prof. W. G. Adams in the Chair.

New members—Mr. J. F. Moulton and Mr. J. J. Eastwick.

Prof. W. G. **Adams**, the President, exhibited his new measuring polariscope. It consists of three principal parts. The lowest section consists of a mirror, a lens, a Nicol's prism, and two other lenses. The upper section consists of lenses and Nicol's prism arranged in the reverse order. Each lens and Nicol's prism is supported separately by screws, and its position can be altered independently of the others. These two parts form a complete polariscope. Besides these there is a middle piece, consisting of two lenses (nearly hemispheres), forming a box to enclose the crystal immersed in oil, their curved surfaces being concentric. The whole middle piece is supported on the tubes of the upper and lower portions, and may be turned about the optical axis of the instrument. The vertical graduated circle carrying the central lenses and crystal may be turned through any angle about its horizontal axis. By means of an arc fastened perpendicularly on the graduated circle, with its centre at the centre of curvature of the central lenses, the crystal may be turned about another horizontal axis at right angles to the former, so that the crystal and the central lenses can be turned about each by three axes which are mutually at right angles. By means of a system of toothed wheels in gear with the rims of the central lenses, the crystal and central lenses may be turned separately about the optical axis of the instrument, so as to bring the planes of the optic axes of a biaxial crystal parallel to the plane of the vertical graduated circle.

Sir John **Conroy**, Bart., read a paper "*On the Distribution of Heat in the Spectrum.*" After referring to Dr. J. W. Draper's supposition that all the rays in the spectrum have the same heating effect, and to his statement that owing to the unequal dispersion of the prism for rays of different refrangibility the method that has been usual for determining the calorific intensity of the various parts of the spectrum is an essentially defective one, the author described a graphical method for eliminating the effect of the unequal dispersion of the prisms, and showed that from MM. Fizeau and Foucault's measurements, and also from those of Lamansky and Prof. Tyndall, that the maximum intensity is about the middle of the visible spectrum and not at the red end; and, further, that the curves given by various observers as representing the intensity of the heat in different portions of the spectrum are, in reality, the "dispersion curves" for the particular prisms employed.

Captain **Abney**, R.E., called attention to his published paper "*On the Measurement of the so-called Thermo-Spectrum*," wherein he shows that the distribution of heat in the spectrum is a misnomer, and that what was really measured by Lamansky and Tyndall was the energy absorbed by the lampblack and the absorption due to the prisms used. He considered that there was no inherent heat in the spectrum. He found that Dr. Draper had not taken into account the amplitude.

Prof. **Guthrie** said that Captain Abney had expressed what many thought, namely, that heat was radiant energy.

Mr. **Grant** then described an investigation which he had made into the induction lines round two parallel coils of wire in the primary coil, an intermittent current of electricity from a Leclanché battery flowed; and in the secondary, a telephone was connected up to detect the induction sounds. With this apparatus he found that with the coils kept parallel to each other, there were lines, or rather a surface of minimum induction, surrounding the primary, and that if the secondary were placed in these lines hardly any induction noise could be detected. A diagram, representing a medial section through the coils, showed the lines to proceed from the wire of the coils in two curves resembling parabolas, one from each cross section of the wire outwards.

Dr. **Shettle** then described his experiments proving the lines of force in a bar magnet to run spirally round the bar between the equator and poles, the equator being decentred and oblique across the bar, as shown by diagrams.

Prof. **Rowland**, of Baltimore, made some observations on the new theory of terrestrial magnetism of Profs. Ayrton and Perry. He said the experiments on which the theory was founded had been attributed to Helmholtz, but they were entirely his own, he having gone to Berlin to make them. The new theory had occurred to himself on making these experiments, but he had rejected it because he found that the potential which the earth's surface would require to have would not only cause violent planetary disturbances, but by mutual repulsion drive objects off the earth. He had made also an experiment to see if absolute motion of electricity would cause magnetisation, but failed to get any effect from it. Then he resorted to calculation to find the magnetic effect of relative motion by rotation of a changed sphere of perfect magnetic permeability that is more magnetic than iron. He found that when the sphere was uniformly charged and rotating there would be a magnetic field in its interior; but, instead of the result of Messrs. Ayrton and Perry, that if the earth were charged to a potential of, he believed, 10^8 volts relatively to interplanetary space, the earth's magnetism would be what it is, he found the necessary charge to be $61 + 10^{15}$ volts. In the ordinary atmosphere this potential would produce a spark nine million miles long, and discharge across to the moon. If the moon were electrified to the same degree, the mutual repulsion would overcome the force of gravity between them. He therefore considered terrestial magnetism to be still a mystery. He had also thought that the aurora borealis might be explained by supposing the upper regions of the earth's atmosphere electrified. The winds carrying the upper strata towards the poles, electricity would condense there. This hypothesis is tenable still.

Prof. **Ayrton** said that whether or not the new theory of magnetism should be so rejected depended on whether or not Prof. Rowland's calculations, or those of himself and Prof. Perry, were wrong. It had been found by Sir William Thomson, from experiments at Arran, that the earth was electrified with respect to the air, and that there is a difference of potential of 30 volts between earth and air for each foot of ascent. This gave 1360×10^{12} centimetre-gramme second electrostatic units as the potential of the earth. The new theory required the potential to be 1011×10^{11}, or supposing the earth to be solid iron, or about 14 times more, a wide margin.

Prof. Rowland said he had not seen the calculations of Profs. Ayrton and Perry yet; but he believed his results to be correct, as he had checked them in various ways.

Mr. Bailley exhibited a modification of Arago's experiment, in which a copper disc is caused to rotate continuously by changing the polarity of four electro-magnets underneath by a revolving commutator.

Mr. Conrad Cooke exhibited a single voltaic element showing the internal current. This is done by forming the glass vessel containing the element into a helical tube between the poles, and hanging a galvanometer needle in the interior of the helix; the internal current deflects the needle.

NOTICES OF BOOKS.

Supplement to a Handbook of Chemical Manipulation. By C. Greville Williams, F.R.S. London: Van Voorst. 1879.

Twenty-two years have passed since the author published his excellent handbook. This addition of some 90 pages to the 580 of the original volume is most welcome. We may wish it to have been more complete; we may think some parts of it treated more fully than others; but we are bound to acknowledge that Mr. Greville Williams has, on the whole, combated the difficulties that beset all supplement writers with a very fair measure of success. He has not been hampered by the desire to attain uniformity, but has very properly sacrificed the old notation to the new in the pages now added to his former work, and he freely confesses that he has omitted treating of some large sections of his subject because they could not be discussed adequately within the narrow limits imposed upon him. The following notes may perhaps suffice to show what our author tells us himself, and what he recommends us to seek for in the works he cites.

Under "Furnaces" we have references to the catalogues of Fletcher and Griffin, with an excellent woodcut of the foot-blower devised by the former apparatus designer. Sprengel's specific-gravity apparatus is figured, and its employment described on page 9. Nine pages are given to vapour densities—a favourite subject with the author of this book. The ingenious arrangement for continuous filter-washing figured on page 21 is due to Mr. Greville Williams himself. Another and still more effective piece of apparatus for the same purpose is described and illustrated on page 22. Various pressure filters are noticed on pages 23 to 26. Pressure-tube operations are then described, and afterwards boiling-points, distillations, and melting-points. Under the heading "Volumetric Manipulation," page 38, the use of the Orange No. 3 of Porrier for indicating neutrality in determining acids and alkalies is recommended, examples of and directions for its employment being fully described. This substance is *ammonium dimethylamidoazobenzosulphonat.* For eudiometric improvements reference is made to the memoirs of Russell in the *Chemical Society's Journal.* The next 20 pages of this supplement are occupied with a most instructive and important digest of improvements in organic analysis, especially so far as relates to combustions for carbon and hydrogen determinations; the illustrations accompanying the text are well selected and carefully executed. For many operations in physical manipulation the author refers us to Roscoe's "Spectrum Analysis," and Weinhold's "Introduction to Experimental Physics,' but a few pages are devoted to new forms of galvanic batteries, while an excellent account, with figures, is given of Sprengel's pump.

Altogether the eighty-eight pages of letterpress and the twenty-three illustrations before us are well worth the moderate sum asked for this useful appendix to an invaluable book.

Laboratory Teaching. By C. L. Bloxam. 4th Edition, London: J. and A. Churchill, 1879.

The alterations made in this edition chiefly concern the formulæ now for the first time introduced. The work, perhaps, requires some systematic revision, but there can be no doubt that it still merits and still retains its character as a very useful practical handbook for the beginner in qualitative analysis. We should, however, like to see such phrases as the following modified:—"Sulphide of ammonium or hydrosulphate of ammonia, $(NH_4)_2S$, is common in a state of solution only" (p. 68). Surely this is awkward. So also it is perplexing to the young student to find another formula, namely, NH_4HS, given for hydrosulphate of ammonia in the index, while the terms ammonium sulphide and ammonic sulphide are assigned to the previous formula in another part of the index (pp. 232 and 234). The author justifies some of the discrepancies between his formalæ and his names for chemical compounds by the statement "that an endeavour to be absolutely consistent would injure the practical usefulness of so small a book." This is a dangerous argument. A similar reason is assigned for the assertion on page 142 that dextrin is insoluble in cold water, like starch, gum, soap, and the oxalates and nitrates of urea.

On the Estimation of Phosphoric acid by Magnesia for Commercial Purposes. By E. F. Teschemacher and J. Denham Smith. London: Hardwicke and Bogue, 1879.

This pamphlet of 32 pages, on the special mode adopted by the authors of carrying out the analysis of commercial phosphates, scarcely calls for remark. The writers confess that they "do not care to claim the replacement of tartaric by citric acid, of sulphate by muriate of magnesia." Their process is, in fact, the ordinary oxalic-acid method, complicated by several elaborations, and involving the *simultaneous* employment of oxalic and citric acid in that stage of the work in which the lime is precipitated. This we consider a mistake. The employment of sulphite of ammonia as an aid in retaining iron in solution has well-known advantages, but is not essential to the complete success of the oxalic acid process. With many of the other directions in this pamphlet we are dissatisfied: such directions are those on pp. 24 and 25, where the ammonia magnesian phosphate has but a single hour given it to form and completely separate from a solution; the employment of no less than 350 grain measures of the magnesian precipitant; and the recommendation of a porcelain crucible for the ignition of the precipitate. We should like to have seen a word about the analysis of those natural phosphates in which more than traces of magnesia is present. In the year 1879 surely the terms *muriate* of magnesia and *muriate* of ammonia (p. 24) are a trifle antiquated!

Two New Isomeric Cyanuric Acids.—J. Herzig.—The α-acid differs from the normal cyanuric acid by crystallising with 1 mol. of water instead of with 2. 100 parts of alcohol dissolve 0·349 of the normal acid and 0·556 of the α compound. The β-acid is much more soluble in alcohol and water than either of the above, and if heated in a glass tube it does not evolve vapours of cyanic acid.—*Berichte.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.

No. 65, May, 1879.

Report by M. Aimé Girard on M. Kuhlmann's (junior) Methods of Conveying Acids.—M. Kuhlmann, in place of carboys, employs floating reservoirs in the form of an ordinary boat, fitted with air-chambers to give them sufficient buoyancy. For sulphuric acid of 60° B. and upwards these are constructed of sheet-iron, and have been in successful use for some years on the canals of the North. For hydrochloric acid he uses cylinders of hardened india-rubber, kept in their form by an external framework of wood. A modification of the structure serves for transport by rail.

Report by M. Troost on M. Gaiffe's Galvanic Deposits of Cobalt.—The metal is deposited from a solution of the double sulphate of cobalt and ammonia, and is superior to nickel at once in hardness, tenacity, and in beauty of colour. It is much less oxidisable than iron, but is very easily dissolved by acids.

On the Production, Constitution, and Properties of Chrome-Steels.—M. Boussingault.—An extensive memoir, taken from the *Annales de Chimie et Physique*, the first portion only appearing in the present issue.

Biedermann's Central-blatt.

No. 5, May, 1879.

Prediction of the Weather.—Prof. Klinkerfuss.—The author gives the following conclusions:—The dew-point read off at sunset indicates the minimum temperature for the night. If the dew-point is below 0°, and the sky clear, frost is to be expected. If it is about 5° below the mean temperature for the day, a cold and dry current of air is approaching. Inversely, a high dew-point indicates that a warm and moist current is approaching, when the air may easily reach its point of saturation, rain then being the result. If, in a day hotter than the average, the dew-point equals or exceeds this temperature, thunderstorms may be expected, on account of the quantity of condensed vapour. If the dew-point rises to 20° C., hail may be expected.

Formation of Nitric Acid in Soils.—Prof. Hünefeld.—The author maintains that the higher oxides of manganese, along with magnesic carbonate in contact with water and due access of air, have the power of inducing the formation of nitrites, and subsequently of nitric acid. Affirmative results have been obtained after the materials had been previously found free from oxides of nitrogen.

Examination of the Shells of Molluscs and Crustaceans.—Prof. F. H. Storer.—The shells of molluscs may be regarded as agriculturally worthless, but those of crustaceans contain notable proportions of phosphoric acid, potash, and nitrogen.

Has the Texture of Superphosphate an Influence upon its Efficiency?—Dr. P. Wagner.—The author examines whether of two superphosphates, of equal percentage of soluble phosphoric acid, the one most finely powdered is in all cases the most effectual? He concludes that, if superphosphate is applied to a moderately moist calcareous soil, the absorption of phosphoric acid takes place so rapidly that after a few hours almost the whole is rendered insoluble without having been previously distributed to any extent through the soil. Hence it is requisite, especially on such soils, that the superphosphate should be in the finest possible state of comminution.

Die Chemische Industrie.

No. 4, April, 1879.

This issue consists almost exclusively of discussions on the new tariff as affecting chemicals.

According to the *Breslauer Zeitung* considerable deposits of sulphur are found in the gypsum formation of Upper Silesia, especially at Pschow and Kokoschütz, near Ratibor.

No. 5, May, 1879.

The Patents-Committee of the German Association for Promoting the Interests of Chemical Industry (why, we beg to ask, must German associations assume such intolerably long names?) has held a session at which an interesting communication from the scientific staff of the Baden Aniline Works was read. The authors point out, not apparently with satisfaction, that neither a novel substance nor a novel application of a substance obtained chemically can be patented in Germany. Concerning the preliminary investigation they doubt the possibility of deciding *à priori* on an invention.

Aluminium Sulphate as a Disinfecting Agent.—A. Tedesco.—The author is of opinion that aluminic sulphate has been recently proposed as a means of disinfection, for which purpose he considers it eminently adapted. He ascribes to it the following action:—The ammoniacal products of decomposition are fixed as ammonium sulphate; the liberated aluminium hydrate carries down all suspended particles, forming with them a solid precipitate. The organic cell, in contact with aluminous compounds, absorbs alumina with great avidity, losing thereby its vegetative power, and putting an end to the process of decomposition. He considers bauxite and wochenite the best materials for the preparation of a sanitary sulphate of alumina. Kaolins are readily attacked by sulphuric acid, but are poor in alumina and comparatively costly.

Moniteur Scientifique, Quesneville.

June, 1879.

A great part of this issue is taken up with a discussion on "septicæmia and germs," which appears to have engaged the attention of the Academy of Medicine on March 11 and 18 and May 6 and 13.

Influence of Changes of Temperature on the Deviation which Inverted Sugar produces on Polarised Light.—Paul Casamajor.—See Chemical News, vol. xxxix., pages 212, 234.

Acceleration of Tannin by means of Phosphoric Acid.—E. Ador.—Phosphoric acid prevents the precipitation of albumen by tannin, but it is without action upon gelatin. Hence it enables the tannin to penetrate the hides more rapidly, and renders it possible to use stronger tan-liquors, but there is a loss of weight if the liquors are stirred.

Reply to Prof. F. Selmi's Remarks on the Toxicological Detection of Arsenic.—A. Gautier.—The author contends that his method is not open to objections on the score of the volatilisation of arsenious acid.

Textile Colorist. Vol. i., No. 4, April, 1879.

This issue contains a great quantity of useful matter, but no novelties of general interest.

Les Mondes, Revue Hebdomadaire des Sciences.

No. 5, May 29, 1879.

The statement has been made in M. Figuier's *Année Scientifique* that M. le Vicomte de Vergnette-Lamotte had discovered a photographic method of analysing wines. The only truth in the rumour is that M. de Vergnette-Lamotte has made some microscopic researches on organised bodies present in decomposing wines, and has caused the results to be represented photographically.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 2, 1879.

Certain Metallic Phosphides.—O. Emmerling.—The author heats metals along with phosphorus in glass tubes exhausted of air, sealed, and bedded in iron tubes filled with magnesia, and then gradually heated to dull redness. The tubes are afterwards opened in an atmosphere of carbonic acid. A phosphide of copper CuP was obtained; the magnesium compound was too unstable to admit of analysis. With aluminium, iron, and mercury there was no action. Other compounds obtained were AgP, Cd_2P, Zn_3P_2, and SnP_2.

Behaviour of Meta-nitro-anisol with Ammonia.—H. Salkowski.—Meta-nitro-anisol is not converted by ammonia into meta-nitro-anilin.

Behaviour of Plumbiferous Concentrated Solutions of Potassium Iodide with Hydrogen Sulphide, and on Plumbiferous Crystals of Potassium Iodide.—E. Schering.—Sulphuretted hydrogen does not precipitate all the lead dissolved in solutions of potassium iodide except they are much diluted. The form of plumbiferous crystals is somewhat modified.

Oxidation of Quinine by Potassic Permanganate.—S. Hoogewerff and W. A. van Dorp.—Among other products the authors obtained a nitrogenous tribasic acid, $C_8H_5NO_6$.

Structural Formulæ of the Aromatic Compounds.—E. Wroblevsky.—Not adapted for abstraction.

Constitution of Iso-diphenic Acid and of Fluoranthen.—R. Fittig and H. Liepmann.—Not suitable for abstraction.

Determination at High Temperatures of the Vapour-Densities of Substances which attack Mercury.—L. Pfaundler.—This paper cannot be intelligibly reproduced without the accompanying engraving.

Action of Nitrosyl-chloride upon Unsaturated Hydrocarbons.—Paul Tönnies.—The author is studying the action of nitrosyl chloride upon amylen, anethol, &c., and considers that this reaction affords a convenient means for the production of primary amines.

Mono-chloro-lactic Acid and Bichlor-propionic Acid from Glyceric Acid.—MM. Werigo and Melikoff.—The authors have obtained these acids by heating glyceric acid in sealed glass tubes for three days, with a half or the four- or five-fold volume of hydrochloric acid saturated at 0°.

Boiling-points of the Esters and Ether-esters of the Oxy-acids.—L. Schreiner.—The methyl-ether of an oxy-acid ester boils about 20° lower than the latter; the boiling-point of each ethyl-ether is about equally high with that of the corresponding ester.

On Chrome-blacks upon Wool.—M. Reimann.—In dyeing chrome-blacks upon wool the author considers that chrome-alum—now a residual product from the manufacture of alizarin—may be partially substituted for potassic chromates. He recommends also a mixture of chrome-alum, iron-alum, and tartar, followed up with logwood as yielding a black which combines the advantages of the chrome and of the iron-blacks.

On Dibrom-capric Acid.—C. Hell and P. Schoop.—The composition of this acid is $C_{10}H_{18}Br_2O_2$; it melts at 135°; dissolves sparingly in cold water, and is decomposed by boiling-water.

INSTITUTE OF CHEMISTRY
OF GREAT BRITAIN AND IRELAND.

An Examination in Practical Chemistry in connection with the Institute will be held on Monday, 11th August, and four following days. Examiner—Dr. W. R. HODGKINSON. Candidates are requested to communicate with the Secretary, Mr. CHARLES E. GROVES, Somerset House Terrace, London, W.C.

A Chemist (21), who has had practical experience in works, desires Re-engagement. Good references; no objection to go abroad.—For particulars, &c., address, X. T., Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

A Chemist, who has had several years practical experience, is open to an Engagement. During the last six years has been engaged in the Alkali Manufacture.—Address, W. H. R., Fir Cottage, Weston, Runcorn.

A Young Gentleman is open to an Engagement as Chemist on Works, &c. Has had three years practica experience; First Prizeman in Analytical Chemistry, Royal College of Science, Ireland. Excellent testimonials; no objection to go abroad.—Address, T. C. B., Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

A Young German Chemist (19), who has studied at a Polytechnic School, and is thoroughly conversant with Inorganic and Organic Analysis, is desirous of meeting with an Engagement in England.—Address, L. E., 8, Harpur Street, Theobald's Road, London, W.C.

An Analyst, with first-class testimonials from Laboratories in London, and from Fresenius's Laboratories in Wiesbaden, wishes to meet with Practical Occupation.—Apply, by letter, F.C.S., Mr. Sloper, 126, Holborn, E.C.

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A Practical Treatise on the Examination of Potable Water.

By J. ALFRED WANKLYN, M.R.C.S.,

Lecturer on Chemistry and Physics at St. George's Hospital; Public Analyst for Buckinghamshire, Buckingham, High Wycombe, Peterborough, and Shrewsbury.

*** *This Edition will contain an account of the new* "Moist Combustion Process" *for dealing with the organic matter in water*

London: TRUBNER and CO., Ludgate Hill.

THE CHEMICAL NEWS.

Vol. XL. No. 1025.

NORWEGIUM, A NEWLY-DISCOVERED METAL.

This metal has been detected and isolated by Dr. Tellef Dahll in a sample of copper-nickel from Kragerö, in Skjærgaarden. The colour of the pure metal is white, with a slight brownish cast. When polished it has a perfectly metallic lustre, but after a time it becomes covered with a thin film of oxide. It can be flattened out in an agate mortar, and in hardness it resembles copper. The melting-point is 350° C., and the specific gravity 9·441. Its equivalent appears to be 145·9. Only one oxide, NgO, has been obtained. With sulphuretted hydrogen it gives a brown sulphide, even in strongly acid hydrochloric solutions, which re-dissolves in ammonium sulphide. With a slight addition of potassium ferrocyanide it gives a brown, but with larger proportions a green precipitate. The sulphuric solution is turned brown on the addition of zinc, and the metal is deposited in a pulverulent state. The solutions of this metal are blue, but become greenish on dilution.

We are indebted for this notice to the courtesy of Dr. Dahll, who is continuing the study of the new substance.

ON SOME NEW FORM OF APPARATUS.

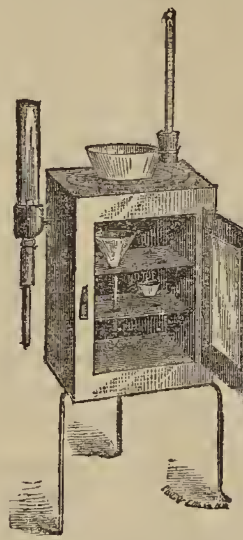
(Second Paper.)

By M. BENJAMIN, Ph.B.

A few weeks ago, under the above title, I described a water-bath[*] with constant level attachments (Chemical News, vol. xxxix., p. 160). That such an apparatus was desirable is evident from several expressions of opinion that have been received by me since its description. In one case I was informed that the bath was allowed to run for forty-eight hours without replenishing the reservoir, thus demonstrating its utility.

The apparatus to which attention is now requested is the out-growth of several suggestions made in reference to the application of the constant level attachment. It is a drying-bath, made of copper, with double walls; having a tubulature in one corner, into which a thermometer may be inserted. By this means an even temperature can be maintained; or, in case the bath is filled with oil, that the heat may be raised to any desired point. On the top is an opening fitted with a series of four concentric rings, which permits the apparatus being used as a water-bath, and, as in the engraving, a porcelain capsule may be heated, while the lower portion is employed to dry filters or to make determinations of moisture. The constant level attachment is shown to the left of the figure, and is manipulated in the same way as the water-bath. Within the oven are two tin shelves, each of which is pierced with four holes to support funnels.

The dimensions of the apparatus are as follows:—Height, 8½ inches; depth, 6 inches, and width 6 inches. In the door I have had placed a sheet of transparent mica; this, I trust, will prove desirable, for, by simply looking in, one may see the conditions of the vessels, without going to the necessity of opening the door.



As both the drying oven and water-bath are indispensable to every analyst, there is reason to believe that some little expense can be saved by combining these two utensils in one, and thus a benefit conferred on the world of chemists.

New York, June 5, 1879.

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[*] In the Chemical News, vol. xxxix., p. 193, a note by Dr. Korn is inserted. As he takes exception to my descriptions, permit me to call his attention to the following facts. While it is quite true that in the *Zeitschrift* for 1872 the constant level attachment is described, it is also quite true that as far back as 1864, in the catalogue of Noellners, the same apparatus is figured (p. 78, fig. 873), but in form it resembles the one described by me about as much as one carbonic acid apparatus resembles another. With regard to the burette clamp, I regret my inability to find its *description* in either Noellners (1864), Leybold (1871), Griffin (1877), or in any American catalogue. Also I beg that Dr. Korn will observe that the clamp works by a spring and not by a screw; this property distinguishes it from all previous forms.—M. B.

THE SOLUBILITY OF STANNIC OXIDE IN HYDROCHLORIC ACID.

By A. E. ARNOLD, Assoc. Inst. Chem.

There appears to be a considerable amount of uncertainty concerning the solubility of natural dioxide of tin or that artificially prepared, in hydrochloric acid.

W. A. Miller,[*] W. Phillips,[†] Greg and Lettsom,[‡] R Fresenius,[§] and "Watts's Chem. Dict." assert the oxide to be insoluble in acids, while J. D. Dana[||] and L. Bombicci,[¶] in their two recent books on mineralogy, observe that it is slightly soluble.

If cassiterite in fine powder, or strongly-ignited stannic hydrate, is digested with strong hydrochloric acid at 100°C., a very perceptible quantity of tin enters into solution as per-salt. The action takes place more energetically above 100° C., when the dioxide is heated in a current of HCl gas. In the complete analysis of cassiterites, therefore, this fact should be borne in mind. As an example, there was found in a specimen of the mineral—

Oxide of tin, insoluble.. ..	38·49 per cent.
,, ,, soluble	0·06 ,,

In a few rare minerals oxide of tin is soluble in considerable quantities in dilute hydrochloric acid, evidently owing to the presence of a stannate of some basic oxide.

The French Association for the Advancement of Science.—The eighth session of this Association will be held at Montpellier, commencing on August 28, the President being M. Bardoux, late Minister of Public Instruction.

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[*] "Inorganic Chemisty," sixth edition, 1878.

[†] 1852.

[‡] "Mineralogy," 1858.

[§] Sixth edition "Quant. Anal."

[||] "Mineralogy," fifth edition, 1875.

[¶] "Course of Mineralogy," 1875-77

CERTAIN
CHARACTERISTIC COLOUR-REACTIONS PRODUCED BY THE ACTION OF AROMATIC HYDROCARBONS AND THE VEGETO-ALKALOIDS ON FUSED ANTIMONY AND BISMUTH TRICHLORIDES.

By WATSON SMITH, F.C.S., F.I.C.

Antimony Trichloride.

Naphthalene.—These reactions are obtained as follows:—About 1½ to 2 grms. of pure crystallised antimony trichloride are fused in a small porcelain crucible, and then further heated somewhat more. Then a small particle of the substance is let fall upon the inner side of the crucible, which is afterwards inclined so that the fluid shall just come in contact with the small particle and envelop it. It melts, more or less dissolved by the heated chloride, to which it communicates in certain cases a certain characteristic colouration, which, on setting the crucible upright again, lengthens itself from a mere spot to a long coloured stripe, more easily observed.

On treating naphthalene in this manner, which is not absolutely pure, a more or less rose-coloured tint is produced, often (though the naphthalene seem quite pure and snow-white) a splendid carmine or crimson tint. If, however, the hydrocarbon be absolutely chemically pure no tint appears. This is, then, a most excellent test for the purity of samples of naphthalene. The subsequent formation on cooling of the beautiful rhombic tables of the addition-compound of antimony trichloride and naphthalene, when the proportions have reached something near 3 : 2, is characteristic of naphthalene.

The reactions with other hydrocarbons were now tried:—

Anthracene.—On adding a mere trace of pure anthracene to a little (1½ to 2 grms.) of the fused trichloride at the bottom of a small porcelain crucible, just as with the naphthalene experiment, a clear yellowish green colouration is produced, not destroyed with excess of hydrocarbon. On cooling, colourless needles may be observed, in all probability of an addition compound of antimony trichloride and anthracene.

Phenanthrene.—This hydrocarbon does not dissolve in the fused trichloride nearly so easily as anthracene does, and on solution gives a faint greenish yellow tint. Now as it is a difficult matter to obtain phenanthrene absolutely free from anthracene, it seems not improbable that the faint tint observed may be due to the presence of traces of anthracene. To endeavour to throw light on this point, I obtained three different samples of phenanthrene, the first brown and impure; the second, almost white, and considered nearly pure; the third, beautifully white and crystalline, and considered absolutely pure. These three samples were subjected to the test in question, when No. 1 gave a strong greenish yellow tint; No. 2, a tint greener than No. 1 but fainter; and No. 3 a faint greenish tint. From this gradation I should be disposed to argue that in all probability anthracene may be distinguished from phenanthrene, if both be absolutely chemically pure, by anthracene giving with the antimony trichloride test a greenish yellow colour, and phenanthrene either giving no tint at all or at most a very faint greenish one.

Diphenyl.—Gives no colouration whatever.

Dinaphthyls.—These hydrocarbons give no colouration.

Phenyl-naphthalene (?)*.—Gives not the slightest tint. (Compare phenanthrene which melts at 100°; phenyl-naphthalene melts at 101° to 102°.)

Stilbene.—For this reaction to proceed well, the fused antimony trichloride must be only so hot that the small crucible containing it can just be supported and held in the fingers. If the smallest speck of the substance now be allowed to fall on the side of the crucible, and the latter be inclined so as to bring the fused mass in contact with the small particle, this is at once turned a deep red or orange-red, and a streak is observed on righting the crucible, extending down its side, of a brick-red or orange-red colour. This tint easily disappears on stronger heating, even if a tolerable excess of hydrocarbon has been used. It thus differs from naphthalene, whose tint is also quite a different one (rose-coloured or crimson). Thus a trace of rose colour observed in applying the test to a sample of stilbene would indicate the presence of naphthalene, especially if on further heating a portion of the colour disappeared, leaving a faint rose tint.

Triphenylmethane.—Gives no colouration. With excess a greenish tint.

Chrysene.—Professor Graebe, of Geneva, kindly furnished me with samples of the hydrocarbons chrysene and pyrene almost quite pure. They were both re-crystallised, chrysene from benzene, and the pyrene from light petroleum spirit. A small speck of the chrysene is let fall on the side of the crucible, and the fluid is then caused to come in contact with it by inclining the crucible slightly. A golden-yellow spot is produced, the chrysene instantly dissolving, and on righting the crucible a yellow streak is observed. Addition of a further and larger quantity of hydrocarbon causes a golden-yellow tint to appear in the trichloride.

Pyrene.—On treating this exactly like the chrysene, it was observed to dissolve with difficulty, giving a faint green or greenish tint. The trichloride requires to be considerably heated to dissolve the hydrocarbon, more so than with the chrysen.

Bismuth Trichloride.

Naphthalene.—Gives under exactly the same circumstances as with the antimony trichloride a brick-red colouration, with a shade of crimson, if not absolutely pure; with chemically pure naphthalene, no tint. On cooling first and immediately before solidifying, fine transparent yellow lanceolate needles separate, most probably consisting of an addition compound of bismuth trichloride and naphthalene, analogous to the antimony compound.

Anthracene.—On dropping the smallest trace of this hydrocarbon into the well-fused chloride it at once becomes a purplish black speck, and on further addition a purplish black colouration is produced.

Phenanthrene.—Gives a brown or greenish brown colour, becoming dark on further addition. It is very probable the dark shade supervening on further addition is due to the presence of traces of anthracene in the phenanthrene. The difference from the anthracene reaction is very great.

Diphenyl.—No colouration whatever.

Dinaphthyls.—With iso-dinaphthyl a very faint brownish tint; with the other two dinaphthyls no change.

I have not continued the experiments with bismuth trichloride, as the difficulty of getting it to fuse readily to a clear liquid makes it far less convenient to employ than antimony trichloride. However, the difference in the anthracene and phenanthrene reactions above noted makes it a valuable means of distinguishing between these two hydrocarbons, in conjunction with the antimony chloride test. Table I. shows more briefly the reactions with the foregoing hydrocarbons.

Reactions with Antimony Trichloride and the Alkaloids.

Conine.—Gives no definite colour reaction.
Nicotine.—Also no definite reaction.

Morphine.—In small quantities no change; in larger quantities, faint greenish tint.
Codeine.—The same as with morphine.
Narcotine.—The fused trichloride being hot enough to fume slightly. A minute crystal fragment let fall in the clear fused chloride turns at once dark olive-green, seeming black. With further addition the fused mass assumes an olive-green or greenish brown tint.

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* This is the hydrocarbon I have recently obtained by passing $C_{10}H_8$ and C_6H_5Br through a red-hot tube. As I have not yet made vapour-density determination or combustion I append the query (?).

TABLE I.

Diphenyl—0	*Naphthalene*—Not quite pure—splendid crimson tint, or rose colour. Absolutely pure, no tint.	*Anthracene*—Clear greenish yellow, or yellowish green. On cooling, colourless needles formed, of an addition compound. With $BiCl_3$—Purplish black	*Chrysene*—Golden yellow.
Triphenyl-methane—0 *Stilbene*—Fine orange red, easily vanishing on stronger heating.	*Phenyl-naphthalene* (?)—0 *Dinaphthyls*—0	*Phenanthrene*—Faint greenish tint if quite pure. With $BiCl_3$—Brown or greenish brown.	*Pyrene*—Green or greeenish tint. Hydrocarbon dissolved with difficulty.

TABLE II.

Volatile Alkaloids.	Opium Alkaloids.	"Strychnos" Alkaloids.	Cinchona Alkaloids.	Unclassified.
Conine—0	*Morphine*—0	*Strychnine*—0	*Quinine*—0	*Veratrine*—(1) and (2) Brick-red.
Nicotine—0	[*Apomorphine*—0]	*Brucine*—(1) and (2) Fine purple-red.	*Cinchonine*—0	*Atropine*—0
	Codeine—0			*Aconitine*—Bronze-brown.
	Thebaine—(1) red. (2)—0			*Santonine*—(1) 0, (2) greenish. With more than trace, (1) 0, (2) dark bluish olive-green.
	Papaverine—0			
	Narcotine—(2) dark olive-green.			
	Narceine—(1) 0, with only trace. Yellow with little more			

Here (1) means antimony trichloride fused and further heated to a small extent. (2) means antimony trichloride fused and further heated considerably. 0 means no tint produced.

TABLE III.

On Strongly Heating the $SbCl_3$ *close to Incipient Ebullition.*

Thebaine.	Veratrine.	Brucine.
Gives *no tint*, or one disappearing again like a flash as soon as formed. Generally no tint at all is perceived, the vanishing is so instantaneous. Heated more strongly, an olive-greenish brown tint is produced.	Gives a flash of red colour more slowly disappearing than is the case with thebaine. If more alkaloid be added the tint does not entirely disappear, but leaves a reddish hue, turning to a brown if still further heated.	With a trace only, a fine red stain, only slowly disappearing, and if more used, refusing to disappear, and on further continuance of the high temperature passing into a purple-brown tint.

Strychnine.—Not the slightest colouration, even with considerable additions of the alkaloid. The fused trichloride remains clear and colourless.

Brucine.—The smallest possible trace or particle of brucine let fall into the fused chloride produces a beautiful red or purple-red colour. This small though fine red stain shows exceedingly well in the surrounding clear, colourless, fused trichloride, with the pure white background formed by the porcelain crucible in which the test is made. This is a most delicate and characteristic reaction for brucine. The tint is produced distinctly, even if the trichloride be heated almost to boiling. At the point of incipient ebullition the tint turns to a red brown with a purplish hue.

Quinine.—No colour change whatever.

Cinchonine.—No change.

Veratine.—A red tint, which may be more exactly defined a "brick-red" tint. The tint disappears, if a minute quantity has been added, on heating more strongly, but if not so small a quantity it only disappears partially, leaving a reddish tint in the fluid.

Atropine.—No colour whatever.

Aconitine.—A brown tint, closely appoaching a *bronze-brown.*

Caffeine.—Gives no tint at all.

Narceine.—A trace gives no tint whatever. A larger quantity let fall into the clear fused mass produces a sulphur-yellow spot, approaching greenish yellow. Disappears on shaking or stirring. Excess of alkaloid colours the mass sulphur-yellow, with faint shade of green.

Apomorphia.—Small quantity, no tint. Larger quantity and strongly heating (though not to incipient ebullition), greenish brown tint.

Santonine.—A trace gives no colouration till heated to incipient ebullition of the trichloride, when a greenish tint is produced. A rather larger quantity also at first scarcely produces any change till more strongly heated as just mentioned, when a dark, bluish, olive-green tint is assumed. This reaction is a very delicate one.

Papaverine.—No tint produced.

Thebaine.—With the least trace let fall on side of the crucible, and the same inclined so as to cause contact of the fused trichloride—a blood-red spot, extending to and producing a blood-like streak on righting the crucible; but the temperature of the fusion must be low enough to allow of the crucible just being supported by and held in the fingers, else the stain (or colour) disappears again instantly. On heating more strongly the stain instantly disappears as soon as formed, leaving a perfectly colourless fluid. With a moderate temperature and larger quantity the fluid is tinted red or blood-red: stronger heating causes (even with excess) almost entire disappearance of the colour. Heating to incipient ebullition causes a new tint to appear, viz., an olive greenish brown, or olive-brown, if the term may be used.

Table II. exhibits more plainly and succinctly these alkaloid reactions.

Brucine, Thebaine, and Veratrine.—In order to test the delicacy of the test as applied to the detection of brucine, a mixture was made of strychine, atropine, cinchonine, quinine, and aconitine, and to this a small trace of brucine was added, and the whole was well mixed up, so as to give a uniform mass. A little of the mixture, about as much as would lie on a pin point, was now dropped into the fused antimony trichloride, when a small but distinct and beautiful red spot or stain was immediately produced. This proves the method to be of great value in detecting the presence of brucine in that of many other alkaloids, the reaction being in no way prejudiced by their presence. Of course veratrine could not be distinguished by this test in presence of brucine, but brucine could easily be distinguished in presence of veratrine on account of the difference of the reds, their different intensities, and the extreme delicacy of the brucine reaction. The test is made just as with the aromatic hydrocarbons, only more minute quantities of the alkaloids may be taken.

The value of the reactions lies in the fact that those alkaloids giving no reaction leave the antimony trichloride absolutely unchanged in appearance,—*i.e.*, transparent and clear—whereas those giving the reactions immediately and sharply strike a colour, a clear and definite test being obtained. The red tints produced by these bodies are modified as follows, by using a high temperature, and this method may be used for distinguishing them. (See Table III.)

Here, again, these tints are best observed by letting the particle fall on the crucible side, and gradually bringing the fused $SbCl_3$ in contact.

I am continuing the investigation of these reactions, and hope soon to furnish further results.

Zürich, University Laboratory, July 6, 1879.

DETERMINATION OF NITROGEN IN THE ANALYSIS OF AGRICULTURAL PRODUCTS.*

By S. W. JOHNSON and E. H. JENKINS.

In 1872 one of us found† that the mixture of caustic soda and caustic lime known as "soda-lime," and used in chemical analysis to determine nitrogen quantitatively, might be replaced by a much more easily prepared mixture of equal volumes of dry sodium carbonate and slaked lime. There is some difficulty in obtaining sodium carbonate suitable for this use. The super-carbonate, which can be readily dried, often contains nitrogen, and the cryatals of sal-soda that, after washing, are free from nitrogen, cannot be quickly dried to a *fine* powder. After various trials the following process of preparing an effective soda-lime was devised:—

Equal weights of sal-soda in clean (washed) large crystals, and of good white and promptly-slaking quick-lime, are separately so far pulverised as to pass holes of $\frac{1}{16}$ inch, then well mixed together, placed in an iron pot, which should not be more than half-filled, and gently heated, at first without stirring. The lime soon begins to combine with the crystal water of a sodium carbonate, the whole mass heats strongly, swells up, and in a short time yields a fine powder, which may then be stirred to effect intimate mixture and to dry off the excess of water, so far that the mass is not perceptibly moist and yet short of the point at which it rises in dust on handling. When cold it is secured in well-closed bottles or fruit-jars, and is ready for use.

During the past year a large number of comparative analyses have been made on bone dust, dried blood, fish-scraps, guano, maize-meal, zein or maize-fibrin, and egg-albumin, using soda-lime obtained as above described, and soda-lime either prepared by ourselves according to the directions of Varrentrap and Will, obtained by purchase (Merck's) or kindly supplied by W. M. Harbishaw, Esq., Chemist to the New York State Agricultural Society. These analyses have proved that the new soda-lime gives perfectly satisfactory results in all cases when soda-lime can be employed, or, at least, results perfectly agreeing with those obtained by the help of the soda-lime as usually prepared. It is not needful to adduce analyses here in support of this statement, since its truth will appear from the soda-lime combustions to be shortly given, all of which were made with this new mixture.

This soda-lime is to be recommended for the reasons that the materials for making it, sodium monocarbonate and quick-lime, are everywhere procurable in a state of purity, the preparation of many pounds of the mixture may be accomplished in an hour or two with little trouble, and the resulting soda-lime is extremely convenient to use, not absorbing moisture in the mixing, and never swelling in the tube to obstruct it on application of heat.

The controversy that has been so actively prosecuted of late years as to the applicability of the soda-lime method of determining nitrogen to the analysis of albuminoid matters, has led us to review the entire subject as far as possible. It is well known to chemists that a number of experimenters—viz., Nowack, Seegen, Nencke, Liebermann, Voelcker, and Musso—have failed to obtain with the soda-lime method as high results on flesh, milk, and similar substances, as by the use of the so-called absolute method, in which the organic body is burned with copper oxide and its nitrogen directly measured in the state of gas. Even Ritthausen, who has stoutly maintained the correctness of the soda-lime method, having employed it in his elaborate researches on the vegetable albuminoids, has very recently admitted that it fails to give all the nitrogen of some of this class of bodies, and has fallen back on the absolute method as the only one to be depended upon.

Since it is a matter of high importance in agricultural and physiological work to use the most exact and especially the most trustworthy methods, we have endeavoured to investigate the correctness of both modes of analysis, to study the sources of error to which they are severally subject, and to learn what is essential to bring out the greatest accuracy they are susceptible of.

We have been led to the conclusion that with the substances above named, both methods when properly worked give nearly accordant results. Dried blood, dried white of egg, and maize-fibrin (crude, obtained by Ritthausen's methods) containing 12 or more per cent of nitrogen, have yielded us from one to two-tenths of a per cent less of nitrogen by the soda-lime combustion than by the absolute method. Our observations satisfy us, moreover, that this discrepancy is no more due to any fault of the soda-lime process than to the errors of the absolute method; errors caused, probably, by the impossibility of removing the last traces of common air from the mixture, either by long-continued transmission of pure carbonic gas or by exhaustion with the Sprengel mercury pump, or by both conjointly.

The following results of analyses by both methods are offered to sustain our assertions. We have not selected these analyses to establish the point, but give all the results we have obtained since learning the best mode of conducting the analytical processes, and they fairly represent what the two methods can accomplish when applied with suitable precautions. (See next column.)

These analyses illustrate a fact which is general in our experience—viz., that the agreement of several determinations made upon one substance is usually closer by the soda-lime than by the absolute method. This fact goes far to show that the soda-lime process is, to say the least, equal in accuracy with the absolute determination.

The full details of the mode we follow in making an analysis by the absolute method cannot be given here. An outline of the process is as follows:—

The substance, mixed with *freshly ignited* copper oxide, is burned in a long glass tube which has been exhausted

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* From the Report of the Connecticut Agricultural Experiment Station for 1878.

† *Amer. Chemist*, vol. iii, p. 161.

	By the Absolute Method. Per cent.	By Soda lime. Per cent.	Average difference. Per cent.
Egg Albumin	12·54	12·34	0·17
	12·51	12·36	
	12·56	12·38	
	12·44		
	12·59		
Maize Fibrin (crude)	13·73	13·60	0·13
Dried Blood	11·90	11·78	0·12
	11·91	11·72	
		11·88	
,,	7·54	7·58	0·04
Fish Scrap	9·21	9·12	0·14
		9·02	
,, ,,	8·79	8·64	0·11
		8·71	
		8·71	
Peruvian Guano	8·27	8·21	0·06
,, ,,	8·63	8·49	0·15
	8·66	8·51	
,, ,,	8·21	8·13	0·12
		8·04	
,, ,,	9·68	9·63	0·03
		9·67	
,, ,,	7·56	7·56	0·00
		7·56	

by means of a mercury pump; the products of combustion after passing over ignited metallic copper, and *finally over ignited copper oxide*,[*] are collected in a graduated receiver, containing fifty per cent solution of caustic potash, and surrounded by a water-jacket. Complete combustion is ensured by heating, in due course, several grms. of potassium chlorate at the rear of the tube, three inches of which is bent downward from the horizontal to retain the fused salt. The residual gas is transferred to the receiver by the pump, brought to a constant temperature by a stream of hydrant water and measured in the usual manner. The mercury pump employed is a very effective one, of simple and easy construction, devised for use in this kind of analysis.

With regard to the handling of the soda-lime method the following results have been arrived at:—

1. Contrary to what is commonly stated, fine pulverisation of the substance to be analysed is not necessary. If the substance will pass holes of one millimetre in diameter it is fine enough.

A sample of dried blood which passed through a sieve with meshes one millimetre in diameter gave 7·58 per cent of nitrogen. A portion of the same, ground extremely fine with sand, gave 7·64 per cent.

Fish-scrap passed through the same sieve gave 8·98 per cent of nitrogen; when ground with sand, 8·95 per cent. A second sample of fish sifted as above gave 8·69 per cent nitrogen. By the absolute method it yielded 8·79 per cent.

2. Neither the highest heat possible to obtain in an Erlenmeyer gas combustion furnace, nor a long layer of strongly heated soda-lime, nor these two conditions united, occasion any appreciable dissociation of the ammonia formed in combustion.

A sample of dried blood gave 11·42 per cent of nitrogen when the combustion was made in a tube 14 inches long at a dull red heat.

The same sample yielded 11·56 per cent when determined in a tube 30 inches long, the mixture occupying 12 inches, and the rinsings and clear soda-lime 16 inches, using as high a heat as possible.

The same experiment was tried with egg-albumin. In a tube 14 inches long it yielded 12·25 per cent; in one 30 inches long, filled as above, 12·34 per cent.

A superphosphate containing animal matter yielded 3·02 per cent of nitrogen when the heat was kept quite low, 3·04 per cent when the heat during combustion was very bright red.

3. The use of pure sugar or of oxalic acid as a diluent does not in any way affect the result.

	Per cent nitrogen.
Dried Blood, 0·5 grm., gave	10·33
,, ,, with 0·5 grm. sugar gave ..	10·29
,, ,, ,, 1·0 ,, ,, ..	10·08[*]
Dried Blood ,, gave	11·56
,, 0·37 grm. with 1 grm. sugar gave ..	11·53
Egg Albumin, 0·5 ,, gave	12·51
,, 0·5 ,, with 0·5 grm. sugar gave	12·41
,, 0·46 ,, ,, ,, ,,	12·50
,, 0·3 ,, ,, ,, ,,	12·54

Experiments with oxalic acid gave similar results.

4. Iron tubes *of proper length* may be substituted for glass. The results are as satisfactory, but more time is required to make the combustion.

The iron tubes used in the following trials were 22 inches long. They were closed at the rear, and at the end of the combustion were cleared of ammonia by heating a mixture of oxalic acid or sugar and soda-lime, which was kept cool in the rear of the tube till needed for this purpose.

	Per cent nitrogen.	
	In glass.	In iron.
Egg Albumin	12·36	12·25
Dried Blood	11·42	11·56
Fish scrap..	9·01	8·99
,, ...	8·71	8·68
,, ...	8·66	8·72
Ammoniated superphosphate..	2·69	2·61
,, ,, ..	2·71	2·68

In the Station Report for 1877 it was stated that combustions in iron tubes yielded 0·2 to 0·5 per cent less than those in glass. This deficiency was occasioned simply by using too short an anterior layer of soda-lime, the tubes being but 14 inches long. Since iron is a good heat conductor these tubes had an effective length much less than glass tubes of the same dimensions would have.

5. A suitable length of the anterior layer of soda-lime must be secured in order to get a good result. With 0·5 grm. of substances, such as are encountered in agricultural chemistry, containing less than 8 per cent of nitrogen, a glass tube of 12 to 14 inches is long enough. As the content of nitrogen increases to 10 per cent or over, we make the tubes several inches longer. In the combustion of dried blood or egg-albumin we *prefer* a tube 25 to 30 inches long, and the mixture of soda-lime and substance should occupy rather less than half the tube, a layer of pure soda-lime of 12 or more inches long being essential for perfectly destroying the volatile organic matters.

6. The long anterior layer of pure soda-lime must be brought to a *full red heat* before heating the mixture, and must be so kept throughout the combustion.

7. No fumes or tarry matters, indicative of incomplete combustion, should appear in bulb-tube or receiver.

8. When the combustion proper is begun under the conditions above described, it can be carried on quite rapidly until completed. The contents of the tubes then show no sign of unburned carbon.

9. We get equally good results whether the mixture is made intimately in a mortar or more roughly by stirring

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[*] The use of a short layer of oxide of copper at the anterior end of the tube was adopted by the writer in 1873, when making analyses of Connecticut tobacco, he having found it impossible to make a blank combustion when using carbonic acid to sweep the tubes, without obtaining unabsorbed gas in the receiver, which proved to be combustible. By burning this gas in the analysis, he was able to get results on uric acid and potassium ferrocyanide agreeing closely with theory and with those obtained by the soda-lime method. More recently, Frankland has adopted this use of copper oxide in nitrogen estimations for water analysis. S. W. J.

Since the above note was printed I have learned that Finkener, in his edition of "Rose's Handbuch," anticipated me in this use of copper oxide. S. W. J.

[*] In this analysis the combustion was not complete, owing to the large amount of sugar being mixed with insufficient soda-lime.

with a spatula in a capsule or scoop, or by mixing in the tube with a wire.

10. We usually allow the glass tube to cool somewhat before aspirating with air to sweep out the ammonia, but have not as yet decided whether this precaution is essential.

11. We receive the ammonia of the combustion in a bulb-tube or flask containining standard hydrochloric acid, and we measure the excess of acid by a standard ammonia solution, using tincture of cochineal as the indicator.

In conclusion, we recall the fact that some careful experimenters—Ritthausen, Mærcker, Petersen, Kreusler—have repeatedly obtained results nearly as accordant as ours in the use of the two methods. Such results could scarcely be accidental, and we express our conviction that the discrepancies observed by others have been due to imperfect working of the processes. We have had great experience with both modes of determining nitrogen (one of us for twenty-five years), and not until recently have we learned how to be fairly certain of our results on *all* the classes of substances we have had occasion to analyse, either with the soda-lime process or by the absolute method. The purity and uniformly satisfactory qualities of the new soda-lime have greatly facilitated our work. The use of cochineal as an indicator we consider very favourable to exact titration.—*American Chemical Journal.*

NOTICES OF BOOKS.

An Introduction to the Practice of Commercial Organic Analysis; being a Treatise on the Properties, Proximate Analytical Examination, and Modes of Assaying the various Organic Chemicals of Preparations employed in the Arts, Manufactures, Medicine, &c., with concise Methods for the Detection and Determination of their Impurities, Adulterations, and Products of Decomposition. By Alfred H. Allen, F.C.S., F.I.C., Lecturer on Chemistry at the Sheffield School of Medicine, Public Analyst of the West Riding of Yorkshire, Borough of Sheffield, &c. Vol. I. Cyanogen Compounds, Alcohols and their derivatives, Phenols, Acids, &c. London: J. and A. Churchill.

On opening this book we were curious to learn how far it had been found practicable to carry out the promises implied by the above somewhat formidable title, and we feel bound to say that a scrutiny proved that the author had justified our anticipations. As stated in the preface, "it is a lamentable fact that while our young chemists are taught to execute ultimate organic analysis, and to ring the changes on the everlasting chloro-, bromo-, and nitro-derivatives of the bodies of the aromatic series, the course of instruction in our leading laboratories does not include even qualitative tests for such every-day substances as alcohol, chloroform, glycerin, carbolic acid, and quinine." Hence the author has set himself to work to compile a text-book of Proximate Organic Analysis, and has succeeded in producing a volume which is in a great measure unique, and which every practical chemist will find most useful. As explained in his preface, the author found the subject matter too extensive for compression into a single volume, and he has therefore reserved various important items for future publication, but the volume now issued is complete in itself and is often exhaustive on the analytical characters of the subtances treated of. The author has divided the volume into seven parts, the first of which, extending over 20 pages, is introductory. This division, in our opinion, is the weak point of the book, and might have been wholly omitted without much loss. However, it contains a useful table of the physical properties and solubilities of a number of organic bodies, and another table of the specific rotatory power of organic liquids. The second division treats of "Cyanogen and its Derivatives," and extends over 43 pages. All the well-known methods of assaying hydrocyanic acid, cyanides, ferrocyanides, &c., are well and clearly explained, and not a little novel matter is incorporated. Indeed, the amount of original information is one of the chief features of the book, there being few of the principal articles which do not contain methods or observations which are the personal experience of the author.

The third division, extending over some 70 pages, treats of the "Alcohols," but the only members of the series fully dealt with are methyl, ethyl, and amyl alcohols, and glycerin. Under ethyl alcohol there is a full description of the methods of examining cider, spirits, liqueurs, and tinctures, but wine and beer are not treated at length in this volume. Methods for the determination of nearly all their chief constituents are, however, to be found scattered throughout the book.

In the next division Mr. Allen treats of "Neutral Alcoholic Derivatives," under which description he classes Compound Ethers, Chloroform, Chloral, &c. As an illustration of the completeness of the book we may say that, as sub-articles under the head of chloroform, the author describes and gives modes of assaying bromoform, iodoform, and methene dichloride, while under "Chloral," butyric or croton chloral, dichloride of propylen, and chloracetic acid are treated of. As a rule the author limits his description to such of the properties of the bodies as are of analytical interest, and the modes of preparation are in most cases very meagrely described.

In the remaining divisions the author treats of "Acid Alcoholic Derivatives and Vegetable Acids," "Phenols," and "Acid Derivatives of Phenols." Space will not allow us to notice these divisions at greater length, but the whole of the information appears to have been carefully compiled, and brought up to the latest date. The author does not confine himself to a description of the reactions and methods of determining organic bodies in a state of purity, but gives practical directions for the assay of such products as tartars, lime and lemon juices, preparations of carbolic acid, tanning materials, and oil of bitter almonds. Mr. Allen assumes the possession of a fair amount of skill in manipulation, and hence the work is well adapted for use by professional and works-chemists, public analysts, and advanced students.

On page 324 the formula of picric acid is written $C_6H_2(NO_2)OH$, but it is shown with three atoms of NO_2 on a subsequent page. On page 326 we are told that "phenyl-sulphuric is a decided antiseptic," the word "acid" being omitted. A formula, said in the list of *errata* to be found on page 176, really appears on page 166. With the exception of these, and a few similar errors of minor importance, the book is remarkably free from mistakes, and is printed in clear type.

We congratulate Mr. Allen on the way he has accomplished a very difficult task, and shall look forward to the issue of the second volume of his original and very useful work.

The Elements of Systematic Qualitative Analysis. By J. H. Snively. Nashville, U.S., 1878.

Tables for Systematic Qualitative Analysis. Same Author.

We have vainly searched for any special feature that we could commend in Mr. Snively's two small books. It is impossible that they should meet with acceptance in England, where manuals of qualitative analysis, at once more exact, more complete, and more moderate in price, are in common use. The author claims no originality, save in arrangement of materials, acknowledging his obligations to Fresenius, Galloway, Attfield, and other writers and workers on the methods of analysis. But the 170 pages to which his manual extends are so incomplete and unsatisfactory that we cannot imagine the authorities he has consulted feeling gratified at the help they have afforded Mr. Snively. The 33 woodcuts with which the book is disfigured are beneath criticism, and can but provoke a smile. Note especially the elegant form of the agate mortar on page 6, and the marvellous perspective of the test-tube rack on page 23. It is scarcely worth while to dwell any further upon the contents of Mr. Snively's manual and tables, but anyone may test the justness of our criticism by reading the section on "Reagents," pp. 31 to 46, noting particularly the directions for preparing lime-water, gold chloride, chlorine-water, platinum tetrachloride, and potassium nitrite.

Twenty Lessons in Inorganic Chemistry. By W. G. Valentin. W. Collins, Sons, and Co., 1879.

This book is one of the most recent of the countless books and booklets to which the Science and Art Department has given birth, and it is undoubtedly one of the very best of the extensive group of works to which it belongs. The late Principal Assistant in the Royal College of Chemistry, South Kensington, Mr. W. G. Valentin, was a most assiduous and energetic teacher, an ingenious and apt manipulator, and a sound chemist. These twenty lessons on the non-metals exhibit in every direction the peculiar merits of their author. He has wisely abandoned the complex formulæ of Dr. Frankland, although explaining the system on which they are constructed. Moreover, he has interspersed his several chapters with a host of little bits of useful information, hints as to the successful performance of experiments, and facts and data not readily accessible elsewhere, so that the volume, small as it is, and elementary as it is meant to be, is not at all like its many rivals in the same field. The illustrations, likewise, are unusually excellent, representing really practicable forms of apparatus, and experiments that can be performed. Although the lines followed by Mr. Valentin are those traced out by the "Science Directory" for students of the elementary grade, we feel sure that the volume before us will be found of much greater value and of much wider usefulness than the ordinary "cram and sham" books to which so many examinees have resort.

CORRESPONDENCE.

VOLUMETRIC DETERMINATION OF CHROMIUM.

To the Editor of the Chemical News.

Sir,—Mr. Galbraith, in a letter to the Chemical News (vol. xxxix., p. 276), refers to a previous publication by himself of a method of estimating chromium, similar to that described by me in the *Journal of the Chemical Society*. Mr. Galbraith's communication had escaped my notice. His method is the same in principle as mine, and I have been unfortunate in having failed to notice it sooner. I am, however, not without hope, that the improved detail and extended application of this method, as shown in my paper, may be of use to those chemists interested in the analysis of chrome iron-ore.—I am, &c.,

W. J. Sell.

July 8, 1879.

SULPHUR IN ICELAND.

To the Editor of the Chemical News.

Sir,—In your review of Dr. Lunge's "Treatise on the Manufacture of Sulphuric Acid and Alkali" (Chemical News, vol. xxxix., p. 287), the statement is made that "the sulphur deposits of Iceland and Saba remain undeveloped." This is incorrect so far as regards Iceland, the fact being that the working of the deposits in Guldbringe Syssel in the south-western corner of the island is being actively prosecuted with satisfactory results.—I am, &c.,

Thos. G. Paterson.

53, George Street, Edinburgh, July 9, 1879.

University of London.—The following condidates have passed the recent D.Sc. Examination:—Branch VI. *Electricity*—(*a*) *Treated Mathematically*. Hugh William McCann, Trinity College, Cambridge. (*b*) *Treated Experimentally*. John Ambrose Fleming, St. John's College, Cambridge. Branch XII. Vegetable Physiology. Sydney Howard Vines, Christ's College, Cambridge.

COMPOSITION AND QUALITY OF THE METROPOLITAN WATER.

June, 1879.

The following are the returns of the Society of Medical Officers of Health:—

	Appearance in 2 foot Tube.	Ammonia.		Nitrogen as Nitrates, &c.	Oxygen used to Oxidise Organic Matter.	Total Solids.	Lime.	Magnesia	Chlorine	Sulphuric Anhydride.	Hardness on Clark's Scale.	
		Saline. Grs.	Organic. Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Before Boiling. Degrees.	After Boiling.
Thames Water Companies.												
Grand Junction	Slightly turbid	0·000	0·012	0·129	0·165	21·00	6·940	0·570	1·150	1·53	13·0	4·2
West Middlesex	Clear	0·000	0·012	0·135	0·037	20·30	7·280	0·720	1·150	1·53	12·6	3·7
Southwark and Vauxhall	Clear	0·000	0·012	0·102	0·129	19·11	6·660	0·500	1·000	1·83	12·1	3·3
Chelsea	Clear	0·000	0·012	0·120	0·033	19·80	6·550	0·790	1·220	2·06	12·0	3·3
Lambeth	Clear	0·000	0·012	0·120	0·070	20·20	6·160	0·570	1·160	2·16	12·6	5·1
Other Companies.												
Kent	Clear	0·000	0·003	0·450	0·002	28·10	8·960	0·910	1·580	2·80	17·6	8·5
New River	Clear	0·000	0·006	0·120	0·059	20·60	7·840	0·800	1·150	1 80	13·2	3·7
East London	Clear	0·000	0·011	0·150	0·048	21·00	8·060	0·460	1·150	1·66	13·2	4·2

The quantities of the several constituents are stated in grains per imperial gallon.

Note.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

C. Meymott Tidy, M.B.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 25, June 23, 1879.

Absorption of Ultra-violet Rays by the Atmosphere.—A. Cornu.—The author brings forward arguments, which, if not absolutely demonstrative, render it extremely probable that the real extent of the solar spectrum on the more refrangible side is considerable, and that it is abruptly cut off by the intervention of a foreign cause. This cause he shows experimentally to be atmospheric absorption. It remains to be ascertained what respective parts are played by the constituents of the atmosphere in this absorption.

Inexact Application of a Dynamical Theorem made by MM. Bertin and Garbe to explain the Movements of the Wings of the Radiometer.—A. Ledieu. (See *Comptes Rendus*, lxxxiv., p. 30).—It results from the objections raised by the author that the cause of the movement of the radiometer must still remain in reserve. The foregoing considerations take no account of the nature of the fluid inclosed in the globe. The reservation of judgment here demanded is corroborated by the diversity of the theories advanced by the most distinguished physicists of all countries to explain the movements of the discs. It is plausible to believe that the cause sought for must be complex, and that we have a superposition of several effects. Attempts should be made to particularise these effects according to a programme of systematised experiments, which may be thus summed up:—Varying the substance of each disc and of its surfaces according to the diverse thermic and luminous properties of the materials employed; modifying successively the nature of the luminous rays and polarising them in various directions with respect to the discs; suspending the globe on two very fine points and enclosing it in a receiver, which is then exhausted.

Representation of the Solar Spectrum.—M. Thollon.—The design laid before the Academy was executed in Italy. It is 10 metres in length from A to H, and is composed of about 4000 rays. For the present he merely calls attention to the singular resemblance of the groups A and B, which have not hitherto been resolved in as complete a manner, and proposes a novel classification of the solar rays according as they are formed of a nebulosity without nucleus, of a nucleus without nebulosity, of a nucleus and a nebulosity, the latter predominating, or of a nucleus and a nebulosity, the nucleus predominating.

Study of the Molecular Constitution of Liquids by means of their Coefficient of Expansion, their Specific Heat, and their Atomic Weight.—R. Pictet.—Not susceptible of abstraction.

Alloys of Lead and Antimony and the Liquations and Supersaturations which they Present.—F. de Jussieu.—Noticed elsewhere.

Production of Hydrocellulose.—A. Girard.—The definite compound which the author has made known under the name of hydrocellulose, and which was obtained by submitting cellulose to the action of liquid or dissolved acids may likewise be formed by the action of gaseous acids.

Reversion of Superphosphates.—H. Joulie.—Superphosphates, even when heavily charged with iron and alumina, if prepared with a sufficient quantity of acid do not undergo a reversion of the assimilable phosphoric acid (soluble in basic ammonium citrate), but they are apt to remain in the state of a soft, elastic paste, unfit for distribution in the soil. If the dose of acid is reduced and the action is incomplete, the mass dries better, but the assimilable phosphoric acid undergoes reversion by the action of the sesquioxides upon the mono- and bicalcic phosphates formed at first, the result being iron and aluminium phosphates, along with tricalcic phosphate, much less soluble in ammonic citrate than the compounds first mentioned. The addition to superphosphates of chalk, or of gypsum containing carbonate of lime as dryers, produces immediately the same phenomenon, which increases with time.

Presence of Oxygen in the Sun.—H. Draper.—The author submitted to the Academy a photographic proof of the blue and violet part of the solar spectrum, and of the spectrum of oxygen. The coincidence of the brilliant rays of oxygen with the brilliant bands of the solar spectrum is a proof in favour of the existence of oxygen in the sun.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 2, 1879.

Anthracen Compounds belonging to the Chrysazin Series.—C. Liebermann.—The author describes the disulph-anthracenates of sodium, potassium, calcium, and barium, chrysazol, diacetyl-chrysazol, diacetyl-chrysazin, chrysazin, tetra-nitro-chrysazin potassium, and the corresponding magnesium compound, also tetra-nitro-anthrarufin potassium and sodium.

The Reduction of Sulph-anthraquinonic Acids.—C. Liebermann.—The author, on treating the salts of mono-sulph-anthraquinonic acid with hydriodic acid (sp. gr. 1·7) and red phosphorus for some hours with an ascending condenser, obtains the corresponding mono-sulph-hydride-anthracenates.

Action of Potassic Carbonate upon Iso-butyl-aldehyd.—F. Urech.—The resulting compound is a semi-fluid, sparingly soluble body, which on distillation is resolved into iso-butyl-aldehyd and certain condensation-products which the author is examining in detail.

Limits of the Applicability of the Method of Determining Vapour-densities in the Barometric Vacuum.—J. W. Brühl.—This paper cannot be usefully abstracted without the accompanying engravings.

A Process for the Purification of Mercury.—J. W. Brühl.—The mercury is shaken up with an equal volume of a solution of 5 grms. potassic bichromate in 1 litre water with the addition of a few c.c. of sulphuric acid, the operation being continued till the water becomes of a pure green. A strong current of water is then introduced into the flask, which washes away a green powder. This process is repeated if needful, and the mercury is finally agitated with distilled water till its surface remains perfectly bright.

No. 3, 1879.

Formation of Sulphonic Acids from Sulphones.—R. Otto.—If two molecules of mono-chlor-hydrin-sulphuric acid are allowed to act upon 1 mol. of the sulphon, the disulphonic acid of sulpho-benzid is formed.

Preparation of Sulphuretted Hydrogen in Chemico-Legal Investigations.—R. Otto.—The author maintains that if either the iron-sulphide or the acid employed is contaminated with arsenic arseniuretted hydrogen is evolved. It is better to prepare the gas by the action of hydrochloric acid upon calcium or barium sulphide, as recommended by Mohr and Grothe. Myers suggests that the traces of arsenic which have been found in the normal animal body may perhaps be due to impure hydrogen sulphide.

Action of Iodine upon Aromatic Compounds with long Lateral Chains.—K. Preis and B. Raymann.—Not suitable for abstraction.

Contributions to a Knowledge of Cholesterin.—K. Preis and B. Raymann.—The authors describe the action of fuming nitric acid upon cholesterin and upon cholesteryl-chloride.

Certain Azo Compounds.—P. Weselsky and R. Benedikt.—An account of azo-benzol-phloro-glucin, para-azo-toluol-phloro-glucin, para-azo-phenol-phloro-glucin, and the azo derivatives of naphthylamin.

Oxidation-products of the Cinchona Bases.—Z. H. Skraup.—This paper does not admit of useful abstraction.

Contribution to a Knowledge of Ultramarine.—E. W. Büchner.—By heating sodium, aluminium, and silicium in a current of sulphuretted hydrogen the author obtained a black mass, which, on extraction with water and re-heating with free exposure to the air, became converted into ultramarine-blue.

Constitution of Phenanthren.—G. Schultz.—The author considers he has proved that diamido-diphenic acid from diphenic acid is identical with that obtained from meta-nitro-benzoic acid.

Phthalein of Ortho-cresol.—G. Fraude.—Not adapted for useful abstraction.

Contribution to the Knowledge of Glyoxylic Acid.—C. Böttinger.—An account of the action of ammonia upon glyoxylic acid.

The Constituents of the Ethereal Oils of Certain Ericaceæ.—H. Kœhler.—An examination of the oils of *Gaultheria punctata* and *G. leucocarpa.*

The Heat Liberated on the Contact of Anhydrous Sodium Sulphate and Water.—L. C. de Coppet.—The author rejects Thomsen's explanation of the rise of temperature as a consequence of the formation of the hydrate, $Na_2SO_4H_2O$.

Specific Rotatory Power of Iso-cholesterin.—E. Schulze.—Of the two isomeric fatty bodies of wool iso-cholesterin is dextro-rotatory, whilst cholesterin is lævo-rotatory.

Determination of the Specific Weight of Pulverulent Bodies.—F. Rüdorff.—The method proposed cannot be intelligibly described without the aid of the accompanying engraving.

Contributions to a Knowledge of Methyl-crotonic Acid and of Angelicic Acid.—E. Schmidt.—The conversion of angelicic acid into methyl-crotonic acid takes place spontaneously in course of time, and in the behaviour of the former a certain resemblance to β-crotonic acid cannot be overlooked.

Azo-derivatives of Diphenyl-amin and Diphenyl-nitrosamin..—O. N. Witt.—An account of the "tropeolin" colours, a name which the author applies to all yellow and orange dyes produced by introducing the sulpho group into amido or oxyazo bodies. The most beautiful among these is the potassium salt of phenyl-amido-azo-benzol-sulphonic acid (tropeolin OO) which gives a fiery golden yellow on silk and wool. The basic properties of amido-azo-benzol are so far neutralised that its application is possible in presence even of weak acids.

A New Universal Support for the Pocket Spectroscope.—F. v. Lepel.—Unintelligible without the accompanying engravings.

The Chemistry of Chondrin.—R. Petri.—On treating chondrin with sulphuric acid and steam the author obtains bodies resembling syntonin, peptons, and a crystalline nitrogenous substance, free both from albumen and peptons. It has the character of a polybasic acid.

Chemiker Zeitung.
No. 20, May 15, 1879.

The proposed duty of 100 francs per 100 kilos. on the importation of patent and proprietary medicines is denounced as implying an official recognition of such articles (a well-known result of the stamp-duty on patent medicines in England).

Prof. Knop denounces "dilettantism in sanitary chemistry," and accuses Dr. Elsner of neglecting analytical precautions, the necessity of which he had formally admitted.

Separation of Ferric Oxide and Alumina from Manganese.—A. Classen's method is based upon the fact that solutions of manganic salts are precipitated by neutral potassium oxalate, the precipitate being soluble in an excess of the latter. The potassium-manganic oxalate is then decomposed by concentrated acetic acid, in which manganese oxalate is insoluble, whilst potassium ferric oxalate formed in the same manner gives no precipitation with acetic acid. To obviate the disturbing action of the alkaline chlorides which prevent the complete precipitation of the manganese oxalate, Classen adds zinc chloride in excess, so that the ZnO may be three or four times the quantity of the MnO. All the manganese is thus precipitated with the zinc oxalate, the cold bulky precipitate is rendered dense and crystalline by heating to 40° to 50°, and is then washed, dried, and ignited with excess of air, forming a mixture of manganese and zinc oxides which often, in consequence of imperfect washing, contains traces of potassium permanganate. The contents of the crucible, after a short ignition, are digested with alcohol and hot water, and washed again. The ignited mixture of Mn_2O_3 and ZnO is decomposed by concentrated hydrochloric acid, the chlorine set free is passed into solution of potassium iodide, and the iodine which separates is titrated with sodium hyposulphite. The filtrate from the oxalates contains ferric oxide and alumina, which, after concentration, are precipitated with alcohol and a little acetic acid, and the ignited precipitate is washed with water containing a little potassium carbonate. The method is likewise suitable for separating calcium, cobalt, nickel, and probably copper from ferric oxide and alumina.—*Zeit. Anal. Chemie*, 1879, p. 175.)

Separation of Manganese and Zinc. — Tamm (Guyard ?) proposed to determine manganese as carbonate by carbonate of ammonium, ammonium chloride having first been added, and applies this reaction to the separation of manganese and zinc. A. Classen points out that the separation is very imperfect.—*Zeit. Anal. Chemie*, 1879, 194.

Volumetric Determination of Free Oxygen in Gaseous Mixtures by Means of Phosphorus.—To determine oxygen in the chamber-gas of sulphuric acid works, Lindemann, after removing the nitrous acid by means of concentrated sulphuric acid, uses, in place of sodium pyrogallate, moist phosphorus, which he introduces in the shape of exceedingly thin rods into the absorption-vessel of an Orsat's apparatus. The traces of phosphorous acid not absorbed by the water have no influence upon the result on account of their slight tension.—*Zeit. Anal. Chemie*, 1879, 158.

Volumetric Determination of Zinc.—C. Mann.—Hydrous zinc sulphide and silver chloride are readily and completely transformed into silver sulphide and zinc chloride. The amount of chlorine present is then ascertained by Volhard's titration process with silver, and the zinc is thus calculated.—*Zeit. Anal. Chemie*, 1879, 162.

Separation of Arsenic and Antimony. –Bunsen's process for separating these two metals by prolonged digestion with potassium sulphide and excess of sulphurous acid has been re-examined by Nilson and found untrustworthy. Bunsen no longer employs this method.—*Zeit. Anal. Chemie*, 1879, 165.

Cupreous Ammonia.—A. Schalm obtained a cupriferous ammonia, perfectly colourless, but which gave a black-brown copper sulphide with sulphuretted hydrogen. The copper is present as cupro-cyan-ammonium.—*Zeit. Oest. Apoth. Ver.*, 17, 189.

No. 21, 1879.

This issue contains nothing calculated to interest our readers.

No. 22, 1879.

The Anglo-Swiss Condensed Milk Co., in reply to the accusations of Dr. Soxhlet and of Baron H. v. Liebig, produce numerous analyses of their condensed milk from Profs. Schulze, Mærcker, Schwarzenbach, Wagner, and others, showing that the cream is not removed before or during the process of condensation.

A specimen of liquid sulphurous acid on view at the Berlin Exhibition exploded with some violence. Fortunately, no one was hurt.

Determination of Superphosphates.—H. Albert and L. Siegfried.—The authors maintain that the hydrated basic and neutral phosphates are substantially equal in value to phosphoric acid soluble in water. A determination of the latter alone does not give the agricultural value of a superphosphate, and is irrational, as it excludes from use phosphorites and other aluminiferous phosphatic minerals. A determination of the total phosphoric acid soluble in ammonium citrate is declared preferable.—*Zeit. Anal. Chemie*, 1879, 220.

Determination of Phosphoric Acid in Fish-guano.—B. E. Dietzell and M. G. Kressner.—In analyses of "Polar" and "Lofoden" guanos the authors obtained concordant results by a twice-repeated evaporation of the ash with concentrated nitric acid. Fusion with soda nitrate in case of Lofoden guano yielded too high results, a certain portion of phosphorus being present not as phosphate, but in organic compound.—*Zeit. Anal. Chemie*, 1879, 225.

Detection of Foreign Fats in Butter.—J. Kœttstorfer.—The author, taking advantage of the fact that butter contains more acids of low molecular weight than other fats, and consequently requires more potassa for saponification, places from 1 to 2 grms. of the filtered sample in a tall covered beaker, holding about 70 c.c., along with 25 c.c. of an alcoholic solution of potassa of about semi-normal strength, and saponifies by heating for fifteen minutes in the water-bath. He then titrates with semi-normal hydrochloric acid, using a very dilute alcoholic solution of phenol-phthalein as indicator. The standard of the potassa solution not being quite permanent is re-determined each time with 25 c.c. heated in the same manner. 1 grm. pure butter fat requires for saponification from 221·4 to 232·4 milligrms. KHO; 1 grm. mutton tallow, 197 ditto; beef tallow, 196·5; hogs' lard and oleo-margarin, 195·5; olive oil, 191·8; and rape oil, 178·7. The author considers his process available for the quantitative detection of rape oil in olive oil.—*Zeit. Anal. Chemie*, 1879, 199.

According to Gawalovski the filter-papers of A. Schmidt, of Gross Ullersdorf, in Austria, are preferable to the Swedish "Munktell." They are much cheaper, very equal in texture, and yield a smaller proportion of ash.

Justus Liebig's Annalen der Chemie,

Band 196, Heft 2.

Nicotin and Nicotinic Acid.—R. Laiblin.—The author gives a method for obtaining pure nicotin in quantity, and then proceeds to the examination of nicotinic acid, $C_6H_5NO_2$, and its derivatives. He considers this acid as pyridincarbonic acid, and attempts its synthesis, but unsuccessfully.

Nature of Cohesion and its Chemical Significance.—Fried. Mohr.

On Chloranilins and Chlornitranilins.—F. Beilstein. and A. Kurbatow.—An extensive memoir, not capable of useful abstraction.

Experimental Researches on Hydrogen Peroxide.—Em. Schoene.—(Fifth Memoir: Behaviour of Hydrogen Peroxide with Ozone and Chlorine).—In the mutual decomposition of ozone and hydrogen peroxide both lose equal quantities of oxygen, whilst the gas in which the former is present expands by a volume equal to the sum of the volumes of oxygen lost by both bodies. The quantity of oxygen evolved in the reaction of chlorine and hydrogen peroxide is double the quantity which the latter contains in excess above water.

Chlorides of Camphor.—F. V. Spitzer.—The author has prepared these compounds by treating camphor with phosphorus chloride.

Les Mondes, Revue Hebdomadaire des Sciences.

No. 6, June 5, 1879.

A new application of the electric light is proposed by M. Trouvé. It is a brilliant light in a closed vessel by means of which it is possible to explore the most "fiery" mines without danger.

M. L. Digeon considers that the phylloxera is most to be dreaded in its winged state, as it is then easily conveyed by the winds. He proposes to syringe the vines from time to time with milk of hydraulic lime.

Nos. 7 and 8, June 12 and 19, 1879.

These issues contain no original chemical matter.

Reimann's Färber Zeitung,

Nos. 18 and 19, 1879.

The most important article in these two issues is a paper by Dr. A. Müller-Jacobs "On the Use of Tannin in Turkey-red Dyeing on the New Principle." The author says:—"The whole art of dyeing, and especially Turkey-red dyeing, depends essentially on a dialysing process, and the object of the oiling or mordanting is merely to convert the vegetable fibre into the best possible dialyser. Parchment (paper ?) and mercerised cotton are dialysers, and both possess in a high degree the property of taking up without mordant such colours as dye without base. The white-mordanted tissue (oiled on the old principle) serves as a dialyser for solutions of alumina. Simultaneously, with the dissociation of the aluminium salts the hydrate of alumina combines with the fixed oleic acid. Of course in this process the chemical affinity of the fixed oil for aluminic salts cannot be overlooked. Mercerised cotton likewise decomposes salts of alumina, and this is still more completely effected by cellulose first mercerised and then oiled on the new method. The process in the dye-bath depends still more upon dialysis than does the mordanting process. The most fiery red is obtained by converting the goods into the best possible dialyser. The *chemical* union of the alizarin with the mordants occurs only at the more elevated temperatures of the dye-beck, when the whole of the colouring matter has been absorbed and the bath has become almost colourless. The more readily the cotton is dialysed by the mordanted cotton (which occurs at low temperatures), *i.e.*, the better the colouring matter 'works on' at a *low* temperature, the more excellent is the red. Additions of chalk, of aluminous salts, &c., even in the smallest quantity, alter essentially the liquid to be dialysed, and have thus a powerful influence on the colour to be produced. This seems to show that the process of dyeing is physical rather than chemical in its nature. On the addition of small quantities of chalk to the dye-bath, *e.g.*, ¼ lb. to 100 lbs. goods, the colouring matter works on much more quickly, the dialysis being accelerated; whilst, on the other hand, the addition of Turkey-red oil, of acids, or alkalies, even in the smallest quantities, or of certain salts, prolongs, or even prevents the dialysis. Cotton, if possible, slightly mercerised and treated with Turkey-red oil, receives by the aid of tannin the power to dissociate aluminic compounds as in the old process, and to fix the hydrate upon the fibre in the state best suited for the production of brilliant colours. By the addition of tannin we compensate for various defects relating to dialysis, and render the addition of Turkey-red oil to the dye-bath possible, whereby the alizarin is absorbed more slowly and a greater equality in the colour is obtained. By fixing large quantities of alumina in the process of mordanting we produce a very fiery red, which lies more on the surface, whilst the fibre remains white internally and the colour scarcely bears a strong soaping. This evil may be avoided by adding tannin to the dye-bath along with Turkey-red oil, thus retarding the dialysis and giving the colour time and opportunity to penetrate into the interior of the fibre. Without tannin we should produce a tawny fugitive red; the addition of chalk (without oil and tannin) would give a red which would not bear clearing. An excess of tannin gives shades which are very fast, but brownish.

No. 20, 1879.

This issue contains nothing of general interest.

No. 21, 1879.

This issue is chiefly taken up with a notice of the Berlin Industrial Exhibition, and with extracts from M. Moyret's exposure of the process of weighting silks.

Behring's Thickener (Glutine).—This adhesive matter consists of casein dissolved in sodium tungstate. It is recommended for a variety of purposes, but for thickening printers' colour it can only be used where the reaction of tungstic acid with the dye-wares present would produce no objectionable effects.

No. 22, 1879.

M. Moyret's paper on weighted silks is continued. For whites and bright shades sugar is used, to which the author proposes an addition of a decoction of quassia. Silk dresses thus prepared would serve for fly-papers. Stannic chloride, mysteriously spoken of in the trade as X, is employed in addition to sugar. Barium sulphate has also been proposed, but it deprives the silk of its lustre.

No. 23, 1879.

Malachite Green and Benzol Green (Victoria Green).—The writer points out, with reference to these two colours—probably identical—a curious discrepancy between the patent system of France and that of Germany. In the former country a chemical product, as such, however produced, may be the subject of a patent. In Germany the process of preparation only is patentable. Thus, if malachite green and Victoria green are identical, the latter colour cannot be made or sold in France except under Dœbner's patent. The author mentions this as an instance showing the necessity for an international patent law.

No. 24, 1879.

According to M. Moyret, 40,000 kilos. of copperas, pyrolignite of iron, and other iron mordants are used daily in the Lyon district for weighting black silks.

A CHEMICAL REMINISCENCE.

There are huge heaps of tank-waste by Sankey's dull stream,
  Hydric Sulphide is reeking there all the day long;
In the hours of my childhood 'twas like a bad dream
  To stay o'er the tank-waste and sniff the fumes strong.
That stream with its odours I ne'er shall forget,
  And often when musing on days that are o'er
I think if the tank-waste is lying there yet
  Are the vapours still choking on Sankey's grim shore?
S.

MISCELLANEOUS.

Reform Club.—Mr. Chas. W. Vincent, F.R.S.E., F.C.S., has been appointed the colleague and successor of Mr. Henry Campkin as Librarian of the Club.

Cerium and Didymium.—Dr. Theodor Schuchardt, of Goerlitz, in a letter to the Editor in May last, stated that he had succeeded in obtaining the metal cerium by electrolysis in globules weighing from 4 to 5 grms. Under date of July 12, Dr. Schuchardt says he has just succeeded in obtaining from didymium chloride, by electrolysis with six Bunsen elements, the metal didymium in globules the size of a small pea.

Valentin Memorial Fund.—We learn with pleasure that many of the friends and former pupils of this well-known Chemist have reponded to the appeal, which as we stated some weeks since, has been made on behalf of the family. There must, however, be others whom previous applications have not reached; we would therefore mention that subscriptions will still be welcomed by the Hon. Treasurer of the Fund, Mr. F. W. Bayley, Royal Mint, E.

Royal Institution of Great Britain.—At the General Monthly Meeting, on Monday, July 7, 1879, Dr. C. W. Siemens Vice-President, in the chair, Messrs. Francis Fesser, James Garnett Heywood, Edmund de Quincey Quincey, Hal Smith, Herbert A. Taylor, and Miss Henrietta Lambert, were elected Members of the Royal Institution. The Special Thanks of the Members were given to the Earl Bathurst, M.R.I., for his munificent Present of a large Bust of William Hyde Wollaston, M.D., F.R.S., M.R.I., by Chantrey.

Royal School of Mines.—The following students have passed the Examinations which entitle them to the distinction of Associate of the Royal School of Mines:—In the Mining and Metallurgical Divisions—Mirza Mehdy Khan. In the Mining Division—W. E. Benton, A. G. Charleton, A. D. Ellis, E. N. Fell, H. B. Slatter, H. Strickland. In the Metallurgical Division—W. B. M. Davidson, A. H. Fison, F. W. Grey, E. Halse, E. W. Harvey, Malcolm Hill, J. H. Lucas, Walter March, A. Gordon Salamon. The two Royal Scholarships of £15 each have been awarded to J. J. Hood and J. F. Wilkinson. The Royal Scholarship of £25 has been awarded to Ralph G. Scott. The De la Beche Medal for Mining to A. D. Ellis, and the Murchison Medal for Geology to B. Mott.

NOTES AND QUERIES.

Soap.—Where can I get information to bleach the oil extracted from olive cake by CS_2 so as to produce a pure white soda soap? The soap I now manufacture has a brownish colour if from old, and greenish if from new oil – R. H.

Wash-bottles.—Several plans have appeared lately in the Chemical News showing appliances for shutting off communication between the interior of wash-bottles and the atmosphere, when it is desired to keep up a jet of water. In this connection allow me to suggest that a small hole bored through the cork is the best and simplest contrivance. By placing the forefinger over the hole it may be perfectly closed without any trouble.—P. Casamajor.

Tetrachloride of Carbon. (Reply to ClC.)—Your correspondent, ClC, may not have seen Bloxam's account of the method of making this substance. Chlorine dried by passing through pumice wetted with strong sulphuric acid, is then made to traverse a Wolff's bottle containing bisulphide of carbon, and is carried onwards through a porcelain tube wrapped in sheet-copper, and filled with fragments of broken porcelain. Kept at a red-heat by a charcoal- or gas-furnace. The products are then condensed in a bottle surrounded by ice. These products when shaken with solution of potash are decomposed. The tetrachloride of carbon then separates and falls to the bottom. The upper layer having been poured off, the tetrachloride may be purified by distillation. (Bloxam's "Chemistry;" Churchill, 1875; page 167; see diagram.) I should myself be glad to know of any better and more convenient process than the above.—F.C.S.

TO CORRESPONDENTS.

G. M. W.—To give the information you require would necessitate writing an essay on the subject.

J. C. H.—Phenic acid or carbolic acid.

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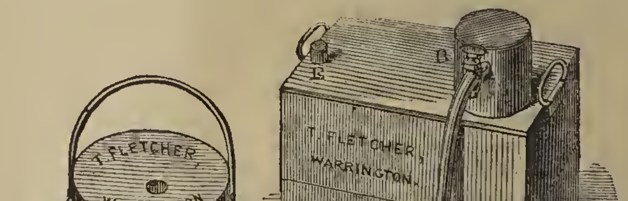

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THE CHEMICAL NEWS.

Vol. XL. No. 1026.

ON MANURE PHOSPHATES.

By K. WALTER,
Chemical Engineer, Aurelais, Belgium.

All natural and manufactured manure phosphates may be divided into the following four groups:—

(1.) Phosphates which are only soluble in acids, and not, or only very slightly, soluble in oxalate of ammonia.
(2.) Phosphates which are quite or for the greater part soluble in the oxalate.
(3.) Phosphates which are quite or for the greater part soluble in citrate of ammonia; and
(4.) Phosphates which are quite or for the greater part soluble in water.

The value, however, of phosphates for agricultural purposes cannot strictly be classed in these four groups. There are soils in which a given quantity of a natural phosphate of, say, 20 per cent of phosphoric acid, has the same effect as the same weight of a superphosphate of 12 to 14 per cent of phosphoric acid. But the price of the first would be about £1 15s. or less, while the price of the latter is at least £4 per ton. On the contrary, there are other soils which absolutely require superphosphate or precipitated phosphates. In some parts of France, mostly in Normandy, for instance, natural phosphates are nearly exclusively used for manuring purposes, and this with excellent effect. The *money* values of the different manure phosphates for different soils cannot be put into strictly divided classes. In the excellent works of H. Toulie[*] the subject of chemical manuring is extensively treated.

To the first of the above-named groups belong chiefly the richer phosphates, such as those of Canada, Curaçao, Navassa, Caçeres, and some other Spanish apatites; then the phosphates of Cambridge, Nassau, Bavaria, Norway, some kinds of the phosphates of the French Ardennes, Lot, Cher; and, finally, the Russian phosphates.

Those phosphates, as well as bone-ash, in which 25 per cent of their phosphoric acid is soluble in oxalate of ammonia, cannot be used with advantage for agricultural purposes, even when finely pulverised. They are nearly exclusively employed for the manufacture of superphosphates. For the manufacture of precipitated phosphate they are much too expensive; natural phosphates containing about 35 to 40 per cent of phosphate of lime—too poor for superphosphate making—being alone profitable.

To the second group belong those precipitated phosphates which have been simply precipitated with milk of lime without observing the necessary precautions. They contain for the most part tribasic phosphate of lime with very little bibasic of the same. This article is not specially manufactured, and only appears in the market as by-product of glue works. It is chiefly produced in France, and the present value in the Paris market is £6 per ton with 30 per cent of phosphoric acid. This phosphate contains on an average 27 to 31 per cent of phosphoric acid, and is used successfully in France for the manufacture of artificial guanos, also for the manufacture of superphosphate. It is but little employed directly for manuring.

If this product is made without a surplus of lime, and dried at a temperature not exceeding 100° C. (=212° F.), it is found, after long experience, to have the same effect on soils which do not contain too little humus. This property has hitherto been recognised by few chemists. However, the time will come when these phosphates will be judged according to their value.

In a well manufactured product of that kind, 90 to 97 per cent of the contained phosphoric acid are soluble in the oxalate, and of those again 25 to 35 per cent in the citrate of ammonia. If, however, this precipitated phosphate is made with a surplus of lime, or dried at too high a temperature, it loses its property of being assimilated by the soil as quickly as superphosphate, and becomes as soluble in citrate as in oxalate.

Next there belongs to this second class the phosphate in the different guanos which contains 50 to 85 per cent of their phosphoric acid soluble in the oxalate. The phosphoric acid in the guano, though only very slightly soluble in the citrate, and in water only in traces, always was considered as highly assimilable. To treat the guano with sulphuric acid, as it became the fashion on the Continent some years ago, is merely done to fix the ammonia.

Further on we have to put in this category the phosphate of the raw bones and of the black-burnt bones, the latter being in rather large quantities on the Continental markets. They contain 45 to 70 per cent of their phosphoric acid soluble in the oxalate. That the phosphoric acid in the two latter named states, of being speedily assimilated in the soil, is known to every farmer. It is not said, however, that they would not profit by being treated with sulphuric acid and converted into bone superphosphate.

Then follow some mineral phosphates, in which 30 to 50 per cent of their phosphoric acid is soluble in the oxalates—as some phosphates of the French Ardennes, in the neighbourhood of Rheims, Dun, Verdun, some phosphates of Cahors, St. Antoine, St. Jean de Laur, Cher, and Lot. All those phosphates are used with excellent effect, only finely ground, for manuring purposes, not only in the neighbourhood of the places named, but even at considerable distances. This proves that their employment was always crowned with decided success; for fresh-brocken woodland, turfy ground and soils rich in humic acids, they exercise an excellent effect, even better than superphosphate could do.

In this category is also to be named a phosphate which is found near Mons, in Belgium, in quantity almost inexhaustible. Up to the present time, however, no means have been found of making use of these layers on an extensive scale. This phosphate is found under three forms:—(1) As phosphatic limestone with 1 to 3 per cent of phosphate of lime. It has been used several years in that region for liming the fields, after being burnt like common limestone. How far the phosphoric acid acts in this manner is very difficult to say. In any case the liming of the fields must have had some success, as it is very generally employed in Belgium for the heavy clay soils. This phosphatic limestone is mostly found at the very surface in layers of 3 to 12 feet in thickness.

(2.) As so-called nodules, a kind of coprolite form in the size of from $\frac{1}{4}$ to 5 inches diameter. These coprolites contain 30 to 40 per cent of phosphate of lime, and are enclosed in a kind of sandy marl containing 5 to 10 per cent of phosphate of lime. The layers have a thickness of 3 to 9 feet, and are for the greater part on the surface. The deeper layers are dug by means of small galleries. The cleaning process of these nodules is carried on in a very simple and rude manner by dry-sifting. They serve, finely ground along with very *rich* phosphates, for manufacturing superphosphate. A large quantity of them is being sent to England. The chief layers, however, are formed by a kind of hard marl of brownish colour, which is found at a depth of 15 to 20 feet in a thickness of 12 to 20 feet. It contains 20 to 35 per cent phosphate of

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[*] "Guide pour l'achat et l'emploie des Engrais Chimiques," par H, Toulie, Pharmacien en chef de la maison municipal de santé Administrateur déligué de la Société anonyme des produits chimiques agricoles. Cinquième edition; Société anonyme. 10, Quay de la Marne à Paris la Vilette, 1876. "Methode citro-uranique pour le dosage de l'acide phosphorique dans les phosphates et les engrais," par H. Toulie, Extrait Complémentaire du *Moniteur Scientifique Quesneville.* Paris, au Bureau de l'Annuaire, 12, Rue de Buci; 1876.

lime, and is dug out in about the same manner as the two other kinds named. Of course there are also immense layers of this latter kind which are poorer in phosphate, and up to the present time have not been considered at all.

There are at present two works on the spot to prepare this marl for the market. The one works with a dry setting and sifting process; the other by burning the broken marl pieces in lime-kilns, and washing out a portion of the lime with water. They both make a sandy-looking phosphate of 50 to 55 per cent of phosphate of lime. In either case there remains too much lime and carbonate of lime to enable it to be used alone in the superphosphate manufactory. All these phosphate minerals of Mons contain a mass of Belemnites and other petrified masses of the kind, mostly the marl, which seems to be entirely composed of such. Though the origin of this mineral appears to be of a comparatively recent period, it is for agricultural purposes worthless, with the exception of soils which contain an unusually large quantity of humus and surf. The reason of this is that carbonate of lime, along with the phosphate of lime, enters very largely into the composition of this mineral.

Dr. Petermann, manager of the Belgian Agricultural Stations, has proved by his extremely profound and well-conducted researches* that the above named phosphate of Mons (Ciply) is unprofitable for agricultural purposes, at least under most circumstances. Not only is this phosphate nearly insoluble in different salt solutions, but it is even capable of extricating out of dunghill drainings the phosphoric acid held in solution, and to precipitate it as a tribasic phosphate of lime *not* soluble in the citrate of ammonia.

From these researches we might conclude that in soils very rich in chalk, as in the Champagne and some parts of England, the plants assimilate the phosphoric acid necessary for their growth as tribasic phosphate of lime. But against this supposition, again, we have the results of Petermann's practical experiments, in which he found that in a poor sandy soil, in which superphosphate was still increasing the harvest very considerably, phosphate of Mons directly employed gave a harvest even inferior to the experiments made without manure phosphate at all. In rich clay soil this astonishing difference was even still more apparent.

The great quantity of carbonate of lime this mineral contains also prevents it from being employed for making superphosphate or precipitated phosphate. A process was proposed to enrich it, which in the laboratory answers well enough if conducted carefully, but on a large scale is impracticable. It is this—to take out the carbonate of lime by means of very weak muriatic acid; but strange to say, there arrives a moment in the process when there is formed precipitated phosphate, while free muriatic acid and carbonate of lime are still present. This precipitate is caused by the carbonate of lime in the solution of phosphate of lime, which latter is dissolved along with the carbonate.

(To be continued.)

New Preparation of Carbolic Acid.—Messrs. F. C. Calvert and Co. have introduced for domestic disinfecting purposes, solidified disinfecting tablets containing 50 per cent of concentrated carbolic acid. The great advantage of this solid form is that it removes the danger of accidental poisoning, and from the high percentage of acid present, the tablets provide, even when dissolved in a considerable quantity of water, a solution capable of arresting all kinds of putrefactive change, and of destroying all the lower forms of insect, vegetable, or germ life.

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* "Seconde Note sur les Gisemente de Phosphates en Belgique, et particuliérement sur celui de Ciply." Par Dr. A. Petermann, Directeur de la Station Agricoie de Gembloux. Brussels, chez Maijolez, 1878.

UPON THE DETECTION AND ESTIMATION OF NITROUS ACIDS IN POTABLE WATERS, ACIDS, &c.

By ALBERT R. LEEDS.

I.—With Meta-diamido-benzol.

This method depends upon the observation, originally made by P. Griess,* that diamido-benzoic acid is an extremely delicate test for nitrous acid, giving in very dilute solutions of this body an intense yellow colour. Later, Griess proposed to employ, instead of this compound, another related compound, *meta-diamido-benzol*, which is more readily prepared, and, moreover, is twice as sensitive as diamido-benzoic acid. The latter indicates the presence of one-fifth m.grm. N_2O_3 in a litre of water; the former, of one-tenth m.grm., or 1 part in 10 million.† Since meta-diamido-benzol is said to be an article of commerce at present there is no need, perhaps, to allude to its preparation. But for those who, like ourselves, were unable to purchase it, it may be of service to know that we were able to prepare it more readily by reduction of the dinitro-benzol by means of tin and hydrochloric acid than by distillation with acetic acid and iron filings.‡ In accordance with the recommendation of Griess, after purifying with animal charcoal, the solution used in testing was acidified with sulphuric acid.

The minutiæ essential to employment of the method in quantitative colorimetric determinations have been elaborated by C. Preusse and F. Tiemann,‖ who recommend—

(1.) A solution of meta-diamido-benzol, containing 5 grms. per litre. It is acidified with dilute sulphuric acid.
(2.) Dilute sulphuric acid solution (1 : 3), for acidifying standard and unknown solutions in process of estimations.
(3.) A solution of alkaline nitrite, of which 1 c.c. contains 0·01 m.grm. N_2O_3. 0·0406 grm. pure dry silver nitrite is dissolved in hot water, and decomposed by potassium or sodium chloride. After cooling, the solution is made up to 1 litre, the silver chloride allowed to settle completely, and 100 c.c. of the supernatant liquid diluted to 1 litre.

The rest of the operations are quite similar in character to those made use of in Nesslerising. But instead of using cylinders of colourless glass, as the above-mentioned authors recommend, comparison-tubes and the colour-comparator§ may be more conveniently employed. 100 c.c. of the aqueous solution under examination is introduced into a comparison-tube, 1 c.c. of solution (2) and 1 c.c. of solution (1) added. If the water is not colourless it should first be decolourised by throwing down the colouring matters through formation of an insoluble carbonate of an alkaline earth in the water containing them. If, on agitation with a bulb-stirrer, a caramel-like colour is developed, the trial is to be repeated with 50, 20, 10 c.c. of the solution, previously diluted to 100 c.c. with water (free from nitrous acid). The dilution is sufficient when a satisfactory reaction is attained in the course of one or two minutes. Various amounts of solution (3) are treated in like manner until an identical tint is developed, when the amount of N_2O_3 in the unknown solution becomes, of course, known.

Inasmuch as the tints of colour developed by the meta-diamido-benzol are so analogous to those exhibited by a dilute caramel solution that they can be closely copied by the latter, the author uses such *a caramel solution in the glass wedge of the colour-comparator for estimations of nitrous acid*. The same wedge, provided with a different scale, answers for the determination of minute amounts of ammonia by the Nessler reagent.

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* *Ann. Chem. u. Pharm.*, cliv., 333.

† *Ber. der Deutsch. Chem. Gesell.*, xi., 625.

‡ "Aromatic Diamines," Hofmann, *Proc. Roy. Soc.*, xi., 518. "Isomeric Diamines," Hofmann, *Ibid.*, xii., 639.

‖ *Ber. der Deutsch. Chem. Gesell.*, xi., p. 627.

§ *Proc. Amer. Chem. Soc.*, vol. ii., p. 1.

Amounts of Nitrous Acid found in Potable Waters.

At the time at which these determinations were made, the water of the Passaic, as drawn from the hydrant in the laboratory, contained 0·12 part N_2O_3 in one million. It is of practical importance to compare this result with the amount of nitric acid contained in the same water. A determination of the sum of nitrates and nitrites (calculated as HNO_3) gave, on the same date (May 2, 1879), 2·37 parts in a million. If we regard this amount of nitric acid as an index of previous sewage contamination, its amount is strikingly great as compared with the nitrogenous matters present in the water and still capable of undergoing putrefactive decomposition. The amount of "nitrates and nitrites" contained in the Passaic, May 2, 1879 (determined by reduction with pig-iron), did not differ notably from the amount found Nov. 26, 1877 (by reduction with the copper-zinc couple), when it was 2·22 parts in a million. The ammonia contained in the Passaic water at latter date was 0·02 part; the albuminoid ammonia, 0·215 part in a million. P. Griess has emphatically insisted upon the importance of determining the nitrous acid in potable waters, and their unfitness for household use when they contain nitrous acid.* In cases like the one cited, where the "nitrates and nitrites," so called, exceed the amount of the albuminoid ammonia *ten times*, there should be no omission to make a separate examination for, and a separate estimation of, the nitrous acid. The rapidity and ease of Nesslerising is such that ammonia and albuminoid ammonia determinations now play the most conspicuous part in reports of water analyses, especially in this country. To accept or condemn from them alone the character of a drinking-water we regard as a practice fraught with error. They should be checked by the results afforded by independent determinations of the nitric and nitrous acids. Fortunately, by aid of improved methods, this can be as readily done as the corresponding estimations of ammonia and albuminoid ammonia, and a skilful water analyst should be able to perform all four within the space of two hours.

We should be very unwilling to say that by reason of the water of the Passaic containing 0·02 part of ammonia and 0·215 part of albuminoid ammonia in a million it was unfit to drink. But these facts, taken in connection with these two others, that it contains at the same time 2·14 parts of nitric acid and 0·12 part of nitrous acid in a million, do, we think, constitute reliable grounds for pronouncing against it. And we regard the two facts last mentioned of more weight in making up this opinion than the two first. Water flowing from a granitic water-shed and over alluvial country, as the Passaic River does, could not readily obtain this percentage of nitrates from inorganic sources—it has most probably come from the oxidation of nitrogenous animal and vegetable matters. And this opinion is confirmed by finding an amount of nitrous acid which is *one-half the total amount of the ammonia-yielding bodies present*, and represents how large a portion of these last are still in a state of transition from their evanescent putrescible form, as albuminoid ammonia, to their permanent stage, as nitric acid.

The water of the Passaic has been taken as an illustration because it happens to be the only potable water which at the present time I have occasion to analyse. But having alluded to it, I trust the importance of the subject will excuse my saying here that the enforced use of water unquestionably so contaminated as this is a crime committed against the health and happiness of a quarter of a million of people.—*Journal of the American Chemical Society.*

"Malco."—This nostrum, vaunted as a prophylactic against the plague and all infectious diseases, consists of 2·5 grms. ammonium carbonate, scented with oil of roses and carbolic acid. It is inclosed in a small leather case, and is worn suspended round the neck!—*Pharm. Zeitung.*

ANALYSES OF THE WATERS OF LAKE THIRLMERE AND THE RIVER VYRNYW, THE NEW SOURCES OF WATER-SUPPLY FOR MANCHESTER AND FOR LIVERPOOL.

By C. ESTCOURT, F.C.S.

In December, 1877, I visited Lake Thirlmere and took samples of the water, one at the head of the lake, and one at its present outlet. I had intended visiting the lake during the ensuing summer for the purpose of observing the difference between the two seasons, but circumstances prevented me from carrying out this intention.

I find that since then Messrs. Grimshaw have analysed samples taken about the end of the summer of last year (namely, August, 1878), see Chemical News, vol. xxxviii., p. 216, and it will probably not be uninteresting to compare the results of the analyses of the winter and summer samples with each other.

During the present summer I visited the River Vyrnyw, at Llanywdden, in Montgomeryshire, at which place the river is for four miles to be converted into a lake for the purpose of supply-water to Liverpool; I procured a sample of the water at a spot within the area of the intended lake. The following are the results of my analyses together with those of Messrs. Grimshaw, of Thirlmere.

	Thirlmere Water Unfiltered.				
Per Gallon.	Estcourt. Head of Lake.	Grimshaw. Upper.	Estcourt. Outlet.	Grimshaw. Lower.	Vyrnyw Filtered. Estcourt.
Total solid matter ..	2·25	2·20	3·10	3·15	5·16
Mineral matter	1·10	1·50	1·15	1·40	1·46
Loss on ignition ..	1·15	0·70	1·95	1·75	3·70
Hardness, all permanent	2·25	1·00	1·50	1·00	2·75
Chlorine	0·58	0·42	0·44	0·70	0·41
Ureal ammonia.. ..			0·0009	0·0021	0·0154
Albuminoid ammonia			0·0042	0·0042	0·0056
Colour..	none		none		Pale yellow.

It will be perceived that all analyses of Thirlmere water gave results within the limits of extreme purity. The difference in the degree of hardness, shown in the analyses of Messrs. Grimshaw and myself, may arise from the use of a different standard solution. One c.c. of the soap solution used in my laboratory is required to produce a lather when 70 c.c. distilled water are shaken with it. Thus the hardness in my samples due to mineral matter will be 1·25° and 0·50° respectively.

In the Vyrnyw water the amount of organic matter which it contains is indicated readily by its peaty colour, and it will be observed the ureal ammonia is high. The unfiltered water contained brownish floating particles which could not be got rid of by decantation, therefore filtration was necessary. After the filtered water had been standing for a fortnight the colour had not diminished in depth.

ON A METHOD FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By S. W. JOHNSON and E. H. JENKINS.

Otto long ago proposed a method for the separation of phosphoric acid from iron and aluminum which was based on the fact that ammonium tartrate will prevent the precipitation of the hydrates and phospates of the metals in alkaline solutions, but does not prevent the precipitation of ammonia-magnesium phosphate.

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* *Ann. Chem. Pharm.*, cliv., 336.

* From the Report of the Connecticut Agricultural Experiment Station for 1878.

W. Mayer[*] has shown that unless a large amount of ammonium salts is present in solution, basic magnesium tartrate will also be precipitated with the phosphate. He prepared a solution for use in the determination of phosphoric acid in which the amounts of magnesium and ammonium salts were in such relation that a precipitation of basic magnesium tartrate was not to be feared. Such a solution cannot be used, however, for the direct gravimetric determination of phosphoric acid in the presence of much lime, because neutral calcium tartrate is apt to be precipitated with the ammonio-magnesium phosphate.

F. Stolba[†] has shown that pure ammonio-magnesium phosphate can be determined by titration as well as by weighing, one molecule of the pure salt requiring two molecules of hydrochloric acid to destroy its alkaline reaction. Advantage has been taken of these observations in devising a plan of operating which should meet the want felt for a rapid and accurate method of determining phosphoric acid in commercial fertilisers. The standard acid used in other volumetric work answers perfectly for this. A strong, nearly saturated, solution of ammonium tartrate, free from carbonic acid, and a solution of some magnesium salt, are also necessary. The latter is prepared by dissolving 70 grms. of magnesium sulphate and 195 grms. ammonium chloride in 1 litre of water. 10 c.c. of this solution contain twice the amount of magnesium necessary to precipitate 0·1 grm. phosphoric acid (P_2O_5). A suitable amount of the phosphate (in most cases 1 grm. is a convenient quantity) is dissolved in hydrochloric acid, the solution nearly neutralised with ammonia, and ammonium tartrate solution is added, 10 c.c. at a time, till the solution remains perfectly clear when slightly alkaline. Add a suitable quantity of the magnesium mixture, and either stir vigorously with a rod, or, if the precipitation is made in an assay-flask, as it can be very conveniently, shake occasionally. When the precipitation is nearly complete add enough ammonia to make it very strongly alkaline, and let it stand six to twelve hours. It can then be filtered, preferably on the pump, and washed with equal parts of strong alcohol, 85 to 90 per cent, and water. No pains are taken to detach the precipitate from the glass. When the dish and precipitate are washed untill the washings no longer react alkaline, the filter and precipitate are brought back into the beaker or flask, a *little* water and a few drops of cochineal tincture are added, and it is titrated. This is best done by adding an excess of standard acid at once, stirring so that all the precipitate shall be wetted with it, and after it has stood a few minutes, measuring back with standard alkali.

The results given below (mostly duplicated) indicate the degree of accuracy to be expected.

	Determined by use of Ammonium Molybdate.	Determined by the Method just described.
Superphosphates, soluble phosphoric acid	8·92 to 8·96	8·83 to 8·91
Ditto, ditto..	8·31	8·32
Ditto, ditto..	11·89 ,, 11·95	11·83 ,, 11·95
Ditto, ditto..	5·14 ,, 5·08	5·07 ,, 5·11
Ditto, ditto..	6·78	6·68 ,, 6·84
Ditto, ditto..	5·63 ,, 5·65	5·61 ,, 5·63
Superphosphates, total phosphoric acid	9·21 ,, 9·28	9·22 ,, 9·32
Ditto, ditto..	10·70 ,, 10·72	10·76 ,, 10·87
[‡]Ditto, ditto..	16·66 ,, 16·66	16·55 ,, 16·65
[‡]Ditto, ditto..	13·94	13·90 ,, 14·05
Hair manure, ditto ..	2·23	2·19
Bone ditto, ditto	21·90 ,, 21·90	21·87 ,, 21·75
Ditto, ditto..	13·21 ,, 13·40	13·19 ,, 13·33
Ditto, ditto..	22·57 ,, 22·62	22·57 ,, 22·76
Ditto, ditto..	21·90 ,, 21·90	21·87 ,, 21·75
Fish scrap ditto, ditto ..	6·17 ,, 6·27	6·17 ,, 6·28

	Calculated.	
Tricalcic phosphate with 6·44 p.c. water	42·85	42·79
The above (0·5 grm.) with 0·22 grm. iron in form of ferric chloride	42·85	42·79

In the case of a few phosphatic materials rich in phosphoric acid, larger discrepancies than any above given have been occasionally encountered, and it is proposed to give them further attention, although it is our impression than they were accidental and do not invalidate the accuracy of the method.

This process requires less than half the time and labour necessary for the molybdic method, is scarcely less accurate, and appears to be generally applicable.

Some investigations, not completed as yet, lead us to hope that ammonium tartrate may be successfully substituted for ammonium citrate for bringing precipitated or reverted phosphates into solution. This step would still further simplify the analyses of superphosphates, since the entire phosphoric acid, soluble, reverted, and insoluble, could be quickly estimated in a single portion.

Our investigations have also demonstrated that while ammonio-magnesium phosphate is totally insoluble in a large excess of ammonium tartrate, it is soluble in excess of ammonium citrate, and hence all methods based on the use of citric acid are faulty.

It is a fact also that ammonio-magnesium phosphate is largely soluble in ferric and aluminic solutions, containing *insufficient* ammonium tartrate.

It is therefore necessary in presence of iron to add ammonium tartrate more than enough to produce a reddish yellow solution, enough, in fact, to make a greenish yellow solution, as Otto has indicated. A similar excess of ammonium tartrate is also requisite in presence of aluminium, and while there is no colour-indication of the suitable quantity, a large excess does not appear to retain ammonio-magnesium phosphate in solution, unless the liquids are too concentrated.—*American Chemical Journal.*

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[*] *Ann. Chem. Pharm.* 101, 164.

[†] *Zeitschr. Chemie*, xvi., 100.

[‡] Navassa superphosphates containing soluble iron and aluminum phosphates.

NOTE ON THE DETERMINATION OF SILICON IN PIG-IRON AND STEEL.[*]

By THOMAS M. DROWN.

In experimenting in connection with Mr. P. W. Shimer (now chemist of the Thomas Iron Company, Hokendauqua, Pa.) on methods for the determination of silicon in pig-iron, in order to find one which should be accurate and yet give results in a few hours, I have adopted the following procedure, which, as far as my experience goes, leaves nothing to be desired.

About 1 grm. of pig-iron or steel is treated in a platinum or porcelain dish with 25 c.c. of nitric acid (sp. gr. 1·2). When action has ceased 25 to 30 c.c. of dilute sulphuric acid (one of acid and three of water) are added, and heat applied until the nitric acid is nearly or quite driven off. The heat of a water-bath is sufficient, though the process may be hastened by heating higher on a sand-bath. Water is then cautiously added (as soon as the free sulphuric acid is sufficiently cool) and the contents of the dish heated until the crystals of ferric sulphate are completely dissolved. The solution is then filtered *as hot* as possible, the residue washed first with hot water then with 25 to 30 c.c. of hydrochloric acid (sp. gr. 1·12), and finally with hot water. After drying and igniting the silica will be found to be snow-white and granular.

The following are some results obtained by this method compared, in some instances, with the older method of treatment with nitric acid, evaporation to dryness, heating to 150° C. for several hours, dissolving out the iron in hydrochloric acid, and filtering off from the insoluble residue, which is dried and ignited, and the resulting impure silica fused with alkaline carbonates.

The letters denote different samples of pig-iron.

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[*] Read before the American Institute of Mining Engineers.

	Per cent of Silicon.							
	A.	B.	C.	D.	E.	F.	G.	Bessemer Steel.
Old method—								
	2·64	2·46		1·45	1·65			0·672
New method—								
1.	2·70	2·47	1·13	1·63	1·53†	1·66	2·50	0·676
2.	2·68	2·47	1·18	1·62	1·51†	1·68	2·50	0·672
3.	2·81*	2·47		1·65	1·51†	1·72	2·50	0·672
4.					1·63‡	1·70	2·47	
5.					1·65‡		2·46	
6.					1·65‡			

Some incidental results obtained in developing this process have enough interest to be worthy of record. Treatment of pig-iron with concentrated sulphuric acid, heating till fumes arise, diluting with water, and filtering after all action has ceased, gives a silica which is seldom pure, and yet the results are considerably too low.

Treatment with dilute sulphuric acid and evaporation till the acid fumes in the air, then filtering after dilution, gives occasionally results which are accurate; but this method is uncertain, depending on the fineness of the borings and character and composition of the pig-iron. The silica obtained is seldom white. The following are some results obtained in this way:—

	Per cent of Silicon.			
	A.	B.	C.	D.
Old method ..	1·02	1·64	2·64	3·85
New method, 1..	1·05	1·73	3·00	3·88
,, ,, 2..	1·05	1·69	2·98	3·91
,, ,, 3..	1·05	1·70	2·97	
,, ,, 4..			3·01	

Treatment in platinum dishes gave very slightly lower results than porcelain dishes.

If, after treatment with dilute sulphuric acid, the solution is filtered off from the residue without concentration of the acid, it is found that about one-half of the silicon is in the solution and the other half in the residue; when nitric acid is used and the solution filtered off as soon as all action has ceased, it is found that about two-thirds of the silicon is in the solution and one-third in the residue; and with hydrochloric acid, about one-third goes into the solution and two-thirds remain in the residue. It is not probable that there is any precise ratio existing between the amount of silicon dissolved and the amount in the residue in the case of any one of the acids, the ratio being doubtless variable and depending on the concentration of the acid, the time of action, and the temperature; yet the marked difference in the action of the three acids in this respect is interesting.

The washing with hydrochloric acid of the residue obtained by the action of nitric and sulphuric acids on pig-iron is in most cases necessary. Thus there was obtained from the pig-iron when water only was used for washing, 2·67 per cent of silicon against 2·52 when washed with hydrochloric acid; and in another sample, 2·10 per cent against 1·70 per cent.

Although the results obtained with hydrochloric acid for the original solution of the iron show, as far as the experiments go, as good results as those obtained with nitric acid, yet I prefer the nitric acid treatment on account of the silica obtained being compact and granular, while the use of hydrochloric acid, and also of sulphuric acid alone, yields a silica which is light and flaky.—*American Chemical Journal.*

According to the *Pharm. Zeitung* American honey can be distinguished from that of European origin by the different character of the pollen grains.

NOTICES OF BOOKS.

Copyright and Patents for Inventions. Vol. I., Copyright. By R. A. Macfie. Edinburgh: T. and T. Clark.

By "reform" of existing patent legislation we have always understood increased facilities and decreased burdens for inventors, so that England may be no longer, as at present, heavily handicapped in its industrial competition with America. Here, however, we find the name "reformers of the actual legislation with respect to books and inventions" coolly allotted to men who are labouring in the very opposite direction, and of whom we are told that "but a few aim at abolishing privilege (!) indiscriminately and entirely.

The author persists in ranking copyright and patent-right among monopolies, and remarks that "they have been spared or instituted when other kinds of exclusive privilege were condemned and abandoned by all statesmen." Might not this very fact suggest to Mr. Macfie and his fellow-believers that these "privileges" have, in reality, no community of nature with monopolies, and were merely confounded with such by the ignorance of our forefathers, just as they confounded whales with fishes and bats with birds? The monopolist is a man who takes something from the public and appropriates it exclusively to himself. The inventor does nothing at all analogous; he makes an exclusive claim to something which, but for him, would have been non-existent. In any case the public, therefore, would be no loser. That if he had not come upon the novelty someone else might is beside the question, for then that other person would have been the inventor. Mr. Macfie's sole ground for denying to a novel invention or a new book the title to rank as property is because it is less easily defined than land, and is not "visible and palpable"—a somewhat flimsy argument. If the author would look round he might meet with things not a few neither visible nor tangible, and certainly not the creation of their holders, which the law recognises as property. Thus if a number of persons associate themselves together, and propose to supply any town with gas or water, the Legislature will give them a perpetual property, not merely in their works, plant, mains, and other "visible and palpable" things, but in the sole right to supply such town. We even suspect that if it were proposed to supersede gas by, say, the electric light, a cry for "compensation" would be raised on behalf of the gas companies. It may, however, scarcely seem fair to discuss the question of patents till the second volume of the work has appeared, though, as far as we can judge from the preface to the volume before us, the author has little to present, save fallacies, which are now very far worn. We will merely remind him that without patents there will be no inventions, and without inventions no trade.

As regards literary property, it seems to be attacked chiefly on the plea that it "enhances their price beyond all bounds." No doubt if the author could be compelled to work gratuitously books would be somewhat cheaper. But why is he alone to be subject to such demands? If the paper-maker, the printer, the bookbinder, and the publisher would all forego wages and profits a still further reduction could be made. Perhaps some of these parties to the transaction could afford to dispense with their emoluments quite as well as the author could forego his "copy-money." If we bear in mind that a scientific book is often the outcome of years of study and research, we shall find that this "copy-money" would often not amount to a stone-breaker's wages for the time consumed.*

The high prices of scientific books in England, in comparison with those prevailing in some other countries seem to have their origin in the following circumstances. Book buyers may be divided into three classes, which we will distinguish as A, B, and C. Class A is composed

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* Not washed with hydrochloric acid.

† In these analyses hydrochloric acid was used after the addition nitric acid, and was not completely driven off.

‡ Hydrochloric acid was used for solution instead of nitric acid.

* Not unfrequently an author receives nothing at all.

of men who care little for the contents of a book, but who will buy any work that "makes a noise," provided it is showily got up. Class B consists of men able to appreciate such books, and who would purchase them in any case. Class C is composed of poor students and men of science in humble circumstances who cannot afford typographical luxuries, though they would be purchasers of a cheaply got-up work. In England, $a + b$ are together much more numerous than $b + c$. Hence the publisher finds it to his interest to bring out every new work of interest in an expensive style. In Germany the Class C is so numerous that scientific works are published in a cheap form for their use. The scheme of publishing on royalty is open to the difficulty that it might not suit the trade. Except an author has a very high name, he finds it no easy matter to arrange with a publisher, and the latter would in most cases decline the transaction altogether unless the copyright were, as now, handed over to him exclusively.

We regret to see a man whose intentions are good labouring perseveringly and ably in opposition to what we consider to be the best interests of his country.

Is the Atomic Weight of Antimony Sb, 120, *or* 122*?* A Reply by Dr. F. Kessler. Bochum: Ad. Stumpf.

The author, after referring to the atomic weight of antimony as given by Berzelius, Sb = 129, and now universally recognised as too high, cites the results obtained by five chemists who have investigated this question. Schneider gives the value as 120·30, Dexter 122·33, Dumas 122·00, the author himself in his earlier researches 122·37, and Cooke 120·00. The material selected by the first-named authority, native antimony-glance, was very probably impure. The results obtained by Cooke differ widely among themselves, and it seems difficult to say why he finally gives the preference to 120. Dexter's result, 122·03, is the mean of 11 determinations, the highest of which showed 122·18 and the lowest 121·93. Hence we see that three chemists, proceeding by totally distinct methods, obtained numbers which arrange themselves very closely round the whole number 122, *i.e.*:—

Dexter	122·03
Dumas	121·95
The Author	121·90

Dr. Kessler, whilst accepting 122 as the nearest approximation to the true atomic weight of antimony, has no intention, however, of declaring himself a supporter of Prout's hypothesis.

Proceedings of the Aberdeenshire Agricultural Association. Report of the Third Annual General Meeting, Season 1878.

The Aberdeenshire Agricultural Association, which is presided over by the Marquis of Huntly, although only three years old, appears to have already largely contributed to our knowledge of the scientific principles of agriculture. Mr. T. Jamieson, the chemist of the Association, has evidently concentrated the whole of his energies upon turnips, which appear to be one of the staple agricultural productions of the ungrateful soil of Aberdeenshire. We wish we had sufficient space to give a summary of Mr. Jamieson's very able report, which in clearness and conciseness is a model of what such a report should be; we can only give the conclusions which he has arrived at after three years experiments. They are as follows:—First, that calcic phosphates, whether of animal or mineral origin, decidedly increase the turnip crop; secondly, that soluble phosphate is not superior to insoluble phosphate to the extent that is generally supposed; thirdly, that nitrogenous manures when used alone have little effect on the crop, but when used in conjunction with insoluble phosphates they increase it; fourthly, that the addition of nitrogen to soluble phosphates does not increase the dry matter of the crop; fifthly, that there is no difference between the effects of equal quantities of nitrogen in sodic nitrate and ammonic sulphate; and, lastly, that fineness of division seems nearly as effective in increasing the crop as the addition of nitrogenous manures. Hence the most economical phosphatic manure for turnips is probably insoluble calcic phosphate from any source, animal or mineral, ground down to an impalpable powder. The tables annexed to the report contain full details of the methods adopted, the analyses of the soil and manures employed, the size of the plots, the number of turnips, the weight of their leaves and bulbs, specific gravity, and percentage of solids in the bulbs. Mr. Jamieson and his able assistants fully deserve all the praise bestowed on them by Mr. J. W. Barclay, M.P., for the carefulness and completeness with which the experiments have been carried out.

We should be only too glad to see every county in England, Ireland, and Scotland follow the excellent example set by hard-headed, hard-soiled Aberdeenshire.

The Retrospect of Medicine, &c. Edited by W. Braithwaite, M.D., and James Braithwaite. Vol. lxxix., January to June, 1879. London: Simpkin and Marshall.

The present issue of this valuable compilation is as usual almost devoid of interest to the chemist, and shows once more conclusively the persistent manner in which the members of the medical profession neglect to search the rich armoury of yet unsheathed weapons placed at their service by chemical science. We do not, however, blame medical men, but the wretched cram system which obliges them to painfully coach up a subject which when studied in the laboratory is delightful, but when learned from books must, we imagine, be especially distasteful. Hence the medical man who is also a chemist is a *rara avis* indeed. One of the only novelties likely to interest our readers is the introduction of pyrogallic acid into medicine by Dr. Vesey, of Dublin, who administers it in grain doses in hæmoptysis and other cases of internal hæmorrhage. The dose is small, and it does not derange the stomach like its congeners, gallic and tannic acids, nor does it cause vomiting as iron and ergot often do. We should imagine that the best way of exhibiting it would be in the form of a spray. The use of arsenic as a cardiac tonic, by Dr. Steward Lockie, of citrate of caffeine as a diuretic, and of sodium ethylate as a topical caustic, may also be mentioned among matters of chemical importance. There is an interesting article on the action of anæsthetics, by Drs. Coats, Ramsay, and McKendrick; and on dichloride of ethidene as an anæsthetic, by the last named investigator, which are models of what such researches should be.

CORRESPONDENCE.

JOHNSTONE'S BAROMETER PUMP.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xl., p. 22, under the heading of "Notices of Books," there appears a review upon C. Greville Williams's "Supplement to a Handbook of Chemical Manipulation," in which the reviewer draws attention to what he calls an excellent account of what is at the present time called the the Sprengel pump.

Circumstances have, until now, prevented my calling attention to an erroneous idea which is in circulation at the present moment, viz., that the invention of what is called the Bunsen and Sprengel pumps, "*solely and only belong to Dr. Sprengel.*" (See Chemical News, vol. xxvii.,

p. 49). The above statement made by Prof. Bunsen, and also the statement by Mr. Williams, that the Bunsen pump, "*is an outcome from Sprengel's discovery*," I give a decided denial to, as neither Dr. Sprengel, or Prof. Bunsen has any claim whatever to the discovery. Dr. Sprengel, in his original paper read before the Chemical Society, made the following statement:—"*The main fact which I have established in this paper may be shortly stated to be that*, if a liquid be allowed to run down a tube, to the upper part of which a receiver is attached by means of a lateral tube, and if the height at which the receiver is attached be not less than that of the column of the liquid which can be supported by the atmospheric pressure, a vacuum will be formed in the receiver, minus the tension of the liquid employed. To the originality of the above statement Dr. Sprengel has no claim whatever, and I now give my reasons for so stating. In the year 1845 James Johnstone (my father) had a patent granted to him under the following title "Specification of the Patent granted to James Johnstone, of Willow Park, Greenock, Engineer, for New and Improved Process and Machinery for Making and Refining Sugar.—Sealed January 31st, 1845." A full description of the patent will be found in "The Repertory of Patent Inventions for 1845" and I extract the following paragraph from the specification of the patent, in which Mr. J. Johnstone says—"I attach a pipe to the bottom of a vacuum pan, so that the saccharine fluid within the pan can freely enter the pipe, and the pan may be emptied thereby. I call this the barometer pipe; it must be made of such length that the weight of the saccharine fluid within it shall counterbalance or rather exceed the weight of the atmosphere, so that when a stopcock at the bottom of the pipe is opened the saccharine fluid within the pan will, of its own weight, rush out by the pipe till the pan is emptied; but the pipe will remain filled with the saccharine fluid in the same manner as a common barometer tube remains full of mercury. The pipe for this purpose will be upwards of twenty-five feet long; the length of the pipe required depends on the specific gravity of the saccharine fluids after they are boiled; the heavier the fluids the shorter the pipe may be made. The preceding is the least expensive method of emptying a vacuum pan without destroying the vacuum, but as it may not always be convenient, instead of the barometer pipe, a pump may be attached to the pan, for the purpose of removing the saccharine fluids without destroying the vacuum; but I prefer the barometer pipe when it can be conveniently used. I claim the making and using of vacuum pans with apparatus attached, so that the contents of the pans may be withdrawn without the vacuum within the pans being destroyed."

I think I have now proved conclusively that those people who persist in speaking of the Johnstone barometer pump as the Sprengel or Bunsen pump have now no warrant for doing so, as the invention belongs solely and only to James Johnstone, he having used mercury as well as saccharine fluids for creating vacuum.—I am, &c.,

William Johnstone.

Lowther Hill, Forest Hill, July 15, 1879.

[The quotations which Mr. Johnstone gives from his father's specification show that the "Johnstone barometer pump" is an entirely different instrument from the "Sprengel pump."—*Ed.* C. N.]

Alloys of Lead and Antimony.—J. de Jussieu.—These alloys melt at 355°, and only give off vapours at a red heat. They dissolve in melted lead and crystallise by liquation in the rhombohedric system. They are capable of being tempered, the effect of which operation is very superficial. They are unstable and are readily decomposed by the action of heat, lead being set at liberty, and a compound richer in antimony being formed.—*Les Mondes.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Justus Liebig's Annalen der Chemie, Band 196, Heft 3.

Certain Sulphur Oxychlorides.—The author, referring to certain experiments by Rose on this subject, considers that the "mother-liquor" of this chemist consisted of the decomposition-products of a small quantity of $S_2O_3Cl_4$ which was formed, and that everything else was unchanged sulphuric anhydride. He has also examined a number of complex selenium compounds, such as sulpho-selen-oxy-tetra-chloride, and the behaviour of sulphuryl-hydroxyl-chloride with the chlorides of titanium, antimony, tin, and silicon.

Colouring Matters and the Glycoside-sugar of Persian Berries.—C. Liebermann and O. Hörmann.—The authors do not consider the colouring matters of quercitron, berries, and fustic as identical. Berries, especially those from *Rhamnius infectorius* and *tinctoria*, even when kept for many years, still contain about 12 per cent pigment glucosides in addition to a little free colouring matter. The glucoside less freely soluble in alcohol is Kane's xanthorhamnin. The more soluble, Schützenberger's β-rhamnegin cannot be regarded as fully established. Xanthorhamnin is split up by acids into rhamnetin and isodulcite, the sugar formed on splitting up quercitrin. Rhamnetin must have Schützenberger's formula, $C_{12}H_8O_3(OH)_2$. Xanthorhamnin and rhamnetin are not identical with quercetrin and quercetin. Lefort's rhamnin is formed by the action of a ferment upon one of the glucosides, and is still a glucoside itself.

On Azophenols.—P. Weselsky and R. Benedikt.—An examination of para-, meta-, and ortho-azophenol and certain of their derivatives.

Action of Water upon the Haloid Compounds of the Alcohol Radicles.—Gustav Niederist.—The author's researches confirm his former opinion that the haloid compounds of the univalent and bivalent radicles, on treatment with excess of water, can almost always be converted into alcohols.

Band 197, Heft 1.

Boiling-points of the Esters and Ether-esters of Oxy-acids.—Dr. L. Schreiner.—Every oxy-acid esters boils almost at the same temperature as its ethyl-ether. If an oxy-acid ester is converted into the corresponding methyl-ether, the boiling-point sinks as when a normal alcohol is converted into methyl-ether.

Methyl- and Dimethyl-diacetonamin.—Dr. Th. Götschmann.—From the facts arrived at it appears that organic amin bases also can act upon aceton with a formation of keton bases, the conversion ensuing in the same manner as with ammonia.

Contribution to the Knowledge of Quinamin.—A. C. Oudemans, jr.—The author gives the preference to the formula first proposed for this compound by Hesse, $C_{20}H_{26}N_2O_2$. He describes the following reactions as characteristic, even for very small quantities. If a drop of the solution of a salt of quinamin is cautiously let flow upon concentrated sulphuric acid containing a trace of nitric acid, there appears, at the point where the two liquids come in contact, a chestnut-brown colour if the liquid is concentrated, but if dilute a rich orange. If the whole mixture is then gradually diluted with water it becomes purple and ultimately a faint rose-red. If a few letters are written upon common thick white paper with a goose-quill dipped in a moderately concentrated solution of quinamin in a slight excess of sulphuric acid, and if the paper is laid with the writing downwards over a watch-glass containing a little strong sulphuric acid and a few granules of potassium chlorate, the characters in a few seconds turn brown or olive. If the paper is removed the letters ultimately turn to a rose colour. If a considerable excess of strong sulphuric acid is added to the quinamin solution prior to the action of chloric peroxide, the letters turn olive more rapidly, and on exposure to the air become sky-blue or deep blue according to concentration. The reaction with chloric peroxide does not occur with quinin, quinidin, cinchonin, cinchonidin, quinicin, and cinchonicin.

Communications from the Laboratory of the University of Kasan.—These consist of a memoir by C. Rjabinin and A. Saytzeff on Diallyl-iso-propyl-carbinol, and a paper by A. Semljanitzin and A. Saytzeff on Oxyvalerianic Acid obtained from Allyl-dimethyl-carbinol.

Behaviour of Certain Nitro Compounds with Sulphuretted Hydrogen.—F. Beilstein and A. Kurbatow.—Tri-substituted chlor-nitro-benzols of unsymmetrical structure are not reduced by sulphuretted hydrogen.

Researches on Compounds of the Camphor Group (Sixth Dissertation).—J. Kachler.—An examination of Borneo-camphor, its components, and behaviour with reagents.

On Glycyrrhizin.—J. Habermann.—In the liquorice root there exists a peculiar nitrogenous acid in a saline state. The acid is tribasic, and yields both acid and neutral salts, among which the acid potassium and ammonium salts are especially distinguished by their tendency to crystallise and by their sweetness.

A Camphen Derived from Camphor and the Synthesis of its Homologues.—F. V. Spitzer.—Not adapted for useful abstraction.

Band 197, Heft 2, 1879.

Experimental Researches on Hydrogen Peroxide.—E. Schœne.—Sixth Treatise:—Behaviour of Hydrogen Peroxide with the Galvanic Current.—The author infers from his experiments that hydrogen peroxide is not an electrolyte, but that in its acidulated solutions the water (or more accurately the acid) alone is subject to electrolysis, the decomposition of the peroxide in the electrolytic liquid being a secondary process, consisting herein that both of the electrolytic products of the decomposition of the water in the nascent state exert a reducing action upon the hydrogen peroxide present around the electrodes. A formation of hydrogen peroxide does not take place during the electrolysis of water. The author points out that permanganates, chromic acid, and lime-water as reagents for hydrogen peroxide require to be applied with caution.

The Two Isomeric Bromides, $C_3H_6Br_2$.—E. Erlenmeyer.—The most favourable conditions for the formation of trimethylen bromide are the maintenance of the largest possible proportion of dry hydrobromic acid to the dry allyl-bromide, till the reaction is completed; secondly, a temperature of 30° to 40°.

Oxychlorides and Chlorides of Tungsten.—Hugo Schiff.—A comment on Teclu's memoir (*Annalen*, Bd. 187, p. 255).

Influence of Isomerism of Alcohols and Acids upon the Formation of Compound Ethers.—N. Menschutkin.—This memoir is not capable of useful abstraction.

On Cinchonidin.—Zd. H. Skraup and C. Vortmann.—An account of the platinum double salt; of cinchonidin hydrochlorate and the neutral sulphate; of the oxidation of cinchonidin with potassium permanganate; and of the preparation and properties of cinchotenidin.

Action of Oxidising Agents upon the Hydrocarbons of the Series C_nH_{2n}.—Dr. O. and F. Zeidler.—The action of the various oxidising agents differs quantitatively, not qualitatively. Potassium permanganate, especially in alkaline solutions, acts more energetically and gives a better yield of bibasic acids, whilst chromic acid and potassium bichromate along with sulphuric acid give chiefly monobasic acids along with small quantities of bibasic acids. The acids formed are, however, in both cases the same.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 4, 1879.

Preparation of Divaleryl.—J. W. Brühl.—The author has succeeded in obtaining divaleryl by a process analogous to that of Freund for the production of dibutyryl.

Succinyl Compounds of the Toluydins.—G. v. Bechi.—The author has obtained certain derivatives of ortho-toluyl-succinimid and the corresponding compounds of the para series.

Action of Dehydrating Bodies upon Camphoric Acid and its Amides.—M. Ballo.—The bulk of the camphoric acid when acted on by dehydrating bodies is decomposed, as is oxalic acid under the same circumstances. A small portion undergoes a more complicated decomposition with the formation of camphoterpen, $C_{20}H_{32}$.

Hydrocarbons obtained by the Action of Chlormethyl upon Benzol in Presence of Aluminium Chloride.—E. Ador and A. Rilliet.—A description of tri-, tetra-, penta-, and hexa-methyl-benzol.

The Photographic Observation of the Oxygen Spectrum.—Hermann W. Vogel.—The spectrum showed the lines described by Paalzow, O*γ* between *b* and E, Oδ close by F, and Oε between F and G. A band of great intensity, which the author names O*η*, lies near *h*. It is sharply defined towards the red end of the spectrum, but shades away towards the violet extremity. A double band, O*s*, near G, has the same character. In the spectrum of hydrogen the three already-known hydrogen lines in the blue and the violet were seen very distinctly, and also the red line, H*α*, coincident with C of the sun. The fourth hydrogen line, coinciding with "*h*" of the sun, was observed with the naked eye by Paalzow and the author, on the application of the simple induction-current, in opposition to the assertion of Lockyer that it is only visible at very high temperatures. Upon this assertion he founds in part his supposition of the decomposition of hydrogen at elevated temperatures.

Oxidation of Lævulic Acid.—B. Tollens.—The products of oxidation are the succinic, acetic, oxalic, formic (?), carbonic, and hydrocyanic acids.

On Phenyl-phosphin.—A. Michaelis and F. Dittler.—The authors describe experiments on the preparation from phenyl-phosphin of carbonyl-phosphin and carbyl-phosphin.

A New Carbazol from Coal-tar.—C. Graebe and W. Knecht.—This compound, for which the authors propose no name, is represented by the formula $C_{16}H_{11}N$. It melts at 330°, dissolves scarcely if at all in cold alcohol and benzol, sparingly in boiling benzol and glacial acetic acid. It is moderately soluble in hot aniline. The solution has an intense blue fluorescence.

Certain Methyl-esters of the Propionic and Butyric Acid Groups.—G. W. A. Kahlbaum.—A table of boiling-points, specific gravities, and indices of refraction.

Behaviour of Dibrom-succinic Acid with Water.—E. Bandrowski.—This acid and its isomer are decomposed on boiling with water.

Correction in a Communication on Atmospheric Hydrogen Peroxide.—E. Schöne.—The figures in the last column of "Table A" express the hydrogen peroxide in 1000 cubic metres of air and not in 1000 c.c.

Action of Chlorine Gas on the Hydrates of Baryta and Strontia.—J. Konigel-Weisberg.—Barium hydroxide takes up no chlorine. The absorption of chlorine depends solely upon an excess of water.

Synthesis of Isatin.—L. Claisen and J. Shadwell.—Cyanide of ortho-nitro-benzoic acid is transformed into a ketonic acid, and the latter again into the amide compound by limited reduction. The next stages are ortho-nitro-phenyl-glyoxylate of potassium, isatate of potassium and isatin.

Decomposition of Tyrosin by Putrefaction.—Th. Weyl.—The author has investigated the production of phenol during the putrefaction of tyrosin. In one case he appears to have obtained para-cresol.

Determination of the Vapour-densities of the Three Isomeric Dinaphthyls.—Watson Smith.—These are $\alpha\alpha = 8{\cdot}70$; $\beta\beta = 8{\cdot}73$; $\alpha\beta = 8{\cdot}77$.

Existence of Nitrous Anhydride as Vapour.—G. Lunge.—Nitrous anhydride partially dissociated by evaporation, but a complete dissociation can be reached neither by mixture with a great excess of air nor by higher temperatures. In most cases a considerable residue, often as much as three-fourths, remains undecomposed, and must exist as nitrous anhydride in the form of vapour. An increasing tendency to dissociation with increased excess of air cannot be denied. The effect of temperature is not demonstrated. Nitrogen trioxide can subsist as vapour even at 150°, but it has in this state a tendency to dissociation, which is increased by the presence of air.

Bulletin de la Société Chimique de Paris,
No. 11, June 5, 1879.

Action of Ammoniacal Salts upon certain Metallic Sulphides and Application of the Facts Observed in Analysis.—Ph. de Clermont.—Already noticed.

Observations on Sulphurous Baths.—Ph. de Clermont and J. Frommel.—The authors believe that the action of certain mineral baths may be explained by means of the electric currents which take place in them.

On Scandium.—P. T. Cléve.—The source of this metal is gadolinite, in which it occurs in very small quantities. It probably does not belong to the yttrium group.

Russian Correspondence.—J. Lermontoff.

M. Gustavson reports on the compounds formed by cymol with aluminium chloride and bromide.

M. P. Goloubeff announces that the product of the reduction of nitrobenzol which he obtained in 1874 is identical with amido-desoxybenzoin.

MM. A. Eltekoff and G. Lagermark have studied the action of sulphuric acid upon acetylen.

M. Potilitzine gave a preliminary communication on the action of oxygen upon haloid salts and the displacement of bromine by chlorine in anhydrous metallic bromides.

M. Louguinine described his results on the influence which the substitution of electro-positive and electro-negative elements, and also of the groups NO_2 and NH_2 for hydrogen, has upon the thermic phenomena accompanying the formation of salts. Aniline and para-toluydin possess very feeble basic powers compared with ammonia. Aniline, when combining with hydrochloric acid, evolves only 7·44 cals. The introduction of an atom of chlorine diminishes the liberation. The heat set free by nitro-para-toluydin in the same reaction is feebler again. In the substitution-products of the phenols the author finds that the introduction of the group NO_2 increases the liberation of heat on combination with Na_2O.

M. J. Goldstein has investigated the boiling-points of the saturated hydrocarbons of normal structure.

M. Andrianowsky publishes researches on the action of the acetic and sulphurous anhydrides upon aluminium chloride.

Notes.—M. S. M. Jœrgensen.—These relate to an anhydrous sodioferric pyrophosphate; a platinoso-platinic oxide, Pt_3O_4; and to the action of silver nitrate upon chloro-platinic acid.—*Journal für Praktische Chemie.*

Atti della R. Accademia dei Lincei.
Fasc. 5, April, 1879.

Influence of Boracic Acid upon Acetic Fermentation.—Prof. A. Herzin.—If an aqueous solution of boracic acid is added to pressed grapes in the proportion of one-twentieth by volume, fermentation is neither arrested nor retarded. The wine produced seems rather clearer than usual, but does not in any way betray the presence of boracic acid. But if the wine is placed in conditions most favourable for conversion into vinegar this change is absolutely frustrated. The author holds that the acetic micoderma lives at the expense of vinegar already generated and not of alcohol, and is a consequence rather than a cause of the chemical changes which are prevented by a trace of boracic acid.

Supposed Identity of Colombin and Limonin.—E. Paterno and A. Oglialoro.—Already noticed.

The Difficulty of obtaining Sulphuric Acid Perfectly Free from Arsenic and other Points Relative to Arsenic.—S. Sella.—For the detection of arsenic in sulphuric acid the author proposes to distill with lead chloride, testing the first portions which pass over with hydrogen sulphide. He suggests treatment with lead chloride for the final purification of sulphuric acid, partially freed from arsenic by sulphuretted hydrogen. Vitreous arsenious acid is not soluble in ponderable quantities in ether, methylic and amylic alcohols, and chloroform. Benzol, oil of turpentine, and the light petroleum oils do not take up a trace.

Fasc. 6, May, 1879.

New Method of Preparing Phenol-glycolic Acid and on Pyro-gallo-triglycolic Acid.—Dr. Piero Giacosa.—The author heats together in the water-bath equivalent quantities of phenol and mono-chloracetic acid, and adds little by little for each part of phenol 4 parts of a solution of caustic soda (sp. gr. 1·3), stirring the mixture well. The liquid boils, and while still hot forms a crystalline mass, which is the sodic salt of phenol-glycolic acid.

Researches on Boron and Vanadium.—Prof. Bechi.—The author has detected traces of boron in the marls and limestones of Montecatini, in Carrara marble, in basalts and lavas from Etna, and in trachytes from Tuscany. The same element has been discovered in the ashes of plants and in albumen extracted from the blood of oxen. He has found vanadium in argillaceous limestones, in shales, sands, and the ashes of plants.

Crystalline Form of certain Compounds of the Aromatic Series.—Dr. R. Panebianco.—Not capable of useful abstraction.

Chemiker Zeitung.
No. 23, June 5, 1879.

In this issue is a description of the Chemical Department of the Berlin Industrial Exhibition. Particular mention is made of the dyes displayed by the Aniline Company (Aktien Gesellschaft für Anilin-fabrikat), of Rummelsburg. Among their colours are eosin and methyl-eosin, coccin, mandarin, aurantia, silver-grey, malachite-green, Capri-blue, and phosphin.

J. K. Kothe exhibits an alcoholic distillate from pine-leaves, recommended as preferable to phenol for disinfecting sick-rooms.

Dr. Elsner, in replying to the recent strictures of Prof. W. Knop, complains that certain of the highest authorities in chemistry seem to discourage the war waged against sophistication.

The German import duty of 10s. per ton on crude iron took effect on June 30.

No. 24, June 12, 1879.

Complaints have arisen concerning the pollution of the Elbe by the waste waters of the Stassfurt and Aschersleben works.

Prof. C. T. Neubauer died at Wiesbaden on June 2.

The Grey Modification of Tin.—According to Schertehl, tin, under certain unknown circumstances, becomes so brittle as to be crushed between the finger-nails, and has the sp. gr. 5·8. If boiled in water it recovers its ordinary colour and texture, while the sp. gr. rises to 7·3.

According to the *Technologiste* common rosin prevents the formation of acetic acid in fermented liquids without having any disturbing effect on the process of alcoholic fermentation. The peculiar effect of the hop may be due, it is suggested, to its resinous matter rather than to its oils. Resin is added to sweet wines in Greece.

Physiological Action of Atropin.—According to Petit atropin in doses of 0·030 grm. in the form of a subcutaneous injection produced no perceptible effect upon dogs.

No. 25, 1879.

The Berlin Exhibition.—Schmidt and Hänsch exhibit the extremely compendious and portable pocket spectroscope designed by Prof. Vogel. L. Reimann displays a balance which, when loaded with 500 grms., turns distinctly with 0·5 milligrm. P. Stuckrath has a small balance of aluminium carrying only 1 grm., but turning with 1-100 milligrm.

Source of Hippuric Acid in the Urine of the Herbivora.—The origin of this acid has long been ascribed to some substance present in hay, but which has not been identified. Loew, however, has found quinic acid to the extent of 6 grms. in 1 kilo. of air-dried hay.—*Journal Prakt. Chemie.*

Benzoic Acid in the Juice of Cranberries.—Loew has detected this acid in the juice of *Preisselbeeren* (the cranberries of northern and eastern Europe), and considers it the cause of their remarkable antizymotic and antiseptic power.

New Colouring Matter from Ortho-amido-phenol.—Aniline, according to Glaser and Schmitt, can be converted into azobenzol by potassium permanganate or chloride of lime. G. Fischer attempted in the same manner to convert ortho-amido-phenol into the corresponding azophenol. Instead of the latter compound he obtained a colouring matter which sublimed in garnet-red needles, but in very small quantity. On employing potassium ferricyanide as the oxidising agent he got a more plentiful yield. The new substance has slightly basic properties. It dissolves in benzol and in all acids, forming with the latter blue or deep violet solutions. Its formula is $C_{24}H_{10}N_3O_2$.—*Journal Prakt. Chemie.*

Nickelising without Electricity.—According to the *Moniteur Industriel* so much of a salt of nickel is introduced into a 5 or 10 per cent solution of zinc chloride till it assumes the ordinary colour of a nickel-bath. The articles to be coated, previously well cleaned, are laid in this solution and the process is complete in from half an hour to an hour. Cobalt can be deposited in the same manner.

Diamond Hunting in China.—Chinese diamonds are chiefly brought from the province of Shantung. Men put on thick shoes of straw and simply roam about the valleys and the rivers. The rough and pointed diamonds penetrate into the straw and stick fast. The shoes are finally collected together in heaps and burnt, when the diamonds remain in the ashes.—*Technologiste.*

Universal Stomach Powder.—Prince F. W. Barella, of Berlin, appears to be the proprietor of this medicine, which consists of 92·70 per cent bicarbonate of soda, 4·00 per cent common salt, and 2·30 per cent carbonate of lime. A box containing 100 grms. costs eighteen pence.

Colouring Matters from Coal.—Dr. Meusel, of Breslau, prepares colouring matters by treating coal-dust with nitric acid, or with a mixture of alkaline nitrates and sulphuric acid, or with other oxidising agents. A part of the coal is thus rendered soluble with a deep brown colour in alkaline hydrates or carbonates. The black residue serves as a body colour. The brown alkaline solution can either be used at once, or metallic salts of a black or dark brown colour may be precipitated from it, or the precipitate produced by the addition of acids may be used as a pigment.—*Die Allg. Polyt. Zeitung.*

Bleaching Ostrich Feathers.—According to the *Moniteur des Produits Chimiques* feathers are bleached in a bath of 10 grms. barium peroxide to 1 litre water, heated to 30°. In this they remain for forty-eight hours, and are then washed, treated with weak hydrochloric acid, and dried.

No. 26, 1879.

Anthocerin.—F. v. Müller.—This compound is a volatile alkaloid obtained from the aqueous extract of an Australian Solanaceous plant, *Anthoceris viscosa.* The author will shortly report on its composition and on its physiological action.—*Zeitschr. Oest. Apoth. Ver.*

A Mordant from Lees of Wine.—Fresh green lees, with the addition of two-fifths sodium tartrate, are evaporated down to one-sixth the original volume. 15 grms. of Cologne glue and 10 grms. tannic acid are added. The mass is pressed, rubbed over with alcohol and tannic acid, dried in the air, and powdered. For use it is to be further mixed with one-fifth per cent sodium tartrate. It is recommended for dyeing full shades in wool and silk, and is said to render the aniline colours permanent. In dyeing woollen cloth a decoction of Saponaria root is added both to the mordant and the dye-bath.

Action of Vinegar upon Alloys of Lead and Tin.—R. Weber.—Vinegar attacks pure tin as well as alloys with lead, the quantity of metal dissolved increasing with the proportion of lead present. Alloys of tin and lead, to which 4 per cent antimony had been added, were also attacked, and lead entered into solution.

Mineral Wealth of Turkey.—The following metals are entirely absent:—Tin, cobalt, nickel, bismuth, and uranium. Chrome iron ore, emery, and copper are plentiful. Coal is found only in the basin of Eregli and Amastra on the Black Sea. There are numerous petroleum wells on the Persian frontier.

No. 27, 1879.

Action of Chloride of Lime upon Ethylic Alcohol.—The formation of chloroform by this reaction and the transition thus effected from the ethyl to the methyl series have not yet been explained. Schmitt and Goldberg find that if chloride of lime is added to absolute alcohol heat is generated in from seven to ten minutes, and distillation sets in. Along with much alcohol a yellowish green oil passes over, which on exposure to light or heat is decomposed with explosion, giving off hydrochloric and hypochlorous acids. In the distillate there are found after the explosion mono-chlor-acetal, dichlor-acetal, chlorinised methyl-ethyl-ether, alcohol, aldehyd, and chloroform.—*Journal Prakt. Chemie*, xix., 393.

Tests for Oils.—Maumené considers that the only trustworthy characteristic of oils is the heat liberated on mixing 50 grms. of the oil with 10 c.c. concentrated sulphuric acid, which is added by means of a pipette, and the whole then well stirred with a thermometer for some minutes, the highest temperature being read off. With pure olive oil the rise is 42°, whilst with linseed it amounts to 103°.

Reimann's Färber Zeitung,
No. 25, 1879.

This issue contains nothing of general interest.

No. 26, 1879.

Benzyl Blue.—This new dye is probably a product of the substitution of rosanilin by three atoms of benzyl. It is readily soluble in boiling water, and is applicable both to animal and vegetable fibres.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 10, July 3, 1879.

This issue contains no original chemical matter.

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. May, 1879.

Aniline-black.—Dr. R. Kayser.—The author has examined the aniline-blacks produced by means of ammonium vanadiate, copper sulphate, and free hydrochloric acid. He recommends that such aniline oils as are free from toluydin, *i.e.*, the lightest, should be exclusively used for aniline-blacks. He rejects Nietzki's view of two isomeric bases, the one of a more blue or violet, and the other of a brownish cast.

Aniline-black.—Dr. R. Nietzki.—The author considers that aniline-black is probably closely connected with the indulins, its colour in a basic state being violet, but when acid, of a greenish cast.

La Correspondance Scientifique.
No. 45, June 10, 1879.

This issue contains no original chemical or physical matter.

No. 46, June 17, 1879.

The Mine-Explosion at Frameries.—It appears from the report of Prof. Burat that more than 100,000 cubic metres of fire-damp must have been evolved in a very short time. All the 200 safety lamps (Mueseler's) were extinguished without causing ignition. The gas issuing from the shaft caught fire *outside* the mine (possibly from the engine furnace), and burnt with an enormous flame. When the supply was becoming exhausted the burning gas ran back into the interior of the mine, followed in its retreat by atmospheric air, and occasioned nine successive explosions. The whole occurrence is considered unexampled in the annals of coal-mining.

Priority of the Discovery of Artificial Ultramarin.—E. Guimet produces documentary evidence that his father, J. B. Guimet, had manufactured artificial ultramarin as early as 1826, and had sent samples to different artists, who pronounced it of excellent quality. In 1827, Ingres used some of it in the decoration of the museum. In 1828, at the time of Gmelin's visit to Paris, and of his conversation with Gay-Lussac, it was already an article of commerce, and had earned the approval of eminent artists.

Die Chemische Industrie.
No. 6, June, 1879.

The Tar Colours and the Electric Light.—Dr. Greiff.—The author contends that even supposing the gas manufacture should ultimately be abandoned the tar colours could be prepared from the residues left on rectifying the petroleum of the regions on the Caspian. These are estimated at 120 million kilos. yearly, and are ten times richer in benzol and five times richer in anthracen than is coal-tar. The American petroleum has not yet been examined from this point of view, but it will probably also prove to be a rich source of aromatic compounds.

MISCELLANEOUS.

A Chemical Reminiscence (Reply to "S.").—

Sankey brook cannot hold its wealth
Which it sadly bears to the sea far out.
If you knew the bait to catch its fish
You would never lament its want of tiout.

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THE CHEMICAL NEWS.

Vol. XL. No. 1027.

BEHAVIOUR OF CHLORINE AT A HIGH TEMPERATURE, OR RESULTS OF VICTOR MEYER'S RECENT RESEARCHES.*

By WATSON SMITH, F.C.S., F.I.C.

In the course of their determinations of the vapour-densities of inorganic substances at high temperatures in the now well-known apparatus devised and perfected by them, my friends Professor Victor Meyer and Carl Meyer have recently turned their attention to the estimation of the vapour-density of chlorine at various high temperatures, viz., the following :—620°, 808°, 1028°, 1242°, 1392°, 1567°. The higher of these temperatures, determined by calorimetric observations, are approximate merely. The chlorine was prepared absolutely pure by heating $PtCl_2$ (or Pt_2Cl_4), and was thoroughly well dried. The resulting vapour-density observations at the named temperatures were as follows :—

	Found.		Theory.
	I.	II.	
At 620° ..	2·42	2·46	For $Cl_2 = 2·45$ (vapour density.)
808 ..	2·21	2·19	
1028 ..	1·85	1·89	
1242 ..	1·65	1·66	1·63 is exactly two-thirds of 2·45
1392 ..	1·66	1·67	
1567 ..	1·60	1·62	

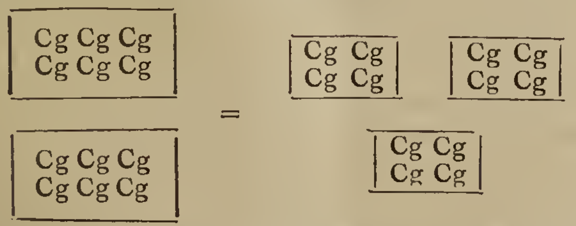
Thus, at 808° an evident "splitting-up," or decomposition, or dissociation commences, which at 1227°, 1392°, and 1567° becomes and remains constant. The molecular weight, then, of chlorine at from 1242° to 1567° would appear to be—

$$\frac{2}{3} \times 71 = 47·3.$$

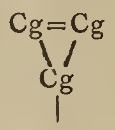
With iodine quite analogous results were obtained, but the experiments are not as yet concluded in this direction. Bringing these observations to bear upon chlorine still regarded as an element, and regarding the amount of permanent expansion resulting in the contraction of vapour-density from 2·45 to 1·63 (viz., two-thirds), also bearing in mind the fact that chlorine in combining with hydrogen to form hydrochloric acid gas does so volume for volume (in equal volumes), uniting without condensation—*then* it becomes evident that (1) the chlorine has suffered a molecular "splitting-up" or dissociation; and (2) the chlorine molecule, Cl - - - Cl cannot even be regarded as consisting of 3 atoms, but must at least contain 6 atoms. Hence the weight of an atom of chlorine would be derived as follows from the molecular weight 70·8—

$$\frac{70·8}{6} = 11·8, \quad = \frac{35·4}{3}.$$

The decomposition may then be represented as taking place in the following manner :—



Therefore $Cl = Cg_3$, and $Cl_2 = Cg_6$, where Cg stands for the hypothetic atom, *Chlorogene*, having the weight 11·8. Further, the atom of chlorogene, Cg, is probably trivalent, and Cl then =

=


Cl_2 (the molecule) =

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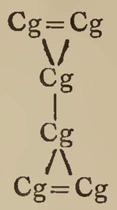
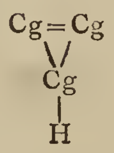
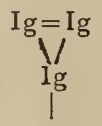


And hydrochloric acid—

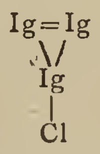


Also iodine, I =

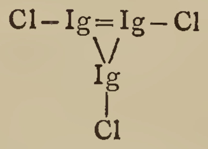


where Ig represents the hypothetic atom Iogene. Thus, the formation and constitution of the iodine chlorides would be thus explained :—

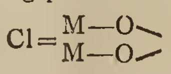
(I.)



(II.)

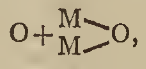


Prof. Meyer next proceeded to a practical examination of the old—once celebrated, but now nearly forgotten—"Murium Theory" of Berzelius, according to which it was supposed that chlorine was, in fact, an oxygen-containing substance—an oxygen compound. This research he has carried out in conjunction with Carl Meyer, and with the object of discovering if any basis existed for this old theory. The experiments have been conducted with the utmost exactitude and care, and every possible error kept away, as far as can be seen—in fact Victor Meyer has invited with gratitude any criticism, and still continues to do so, bearing upon the methods adopted and mode of conducting the experiments. He shows, for example, that the porcelain containing vessel (placed in a Perrot's furnace, and through which the chlorine gas was passed) *could not have contributed any oxygen.* Further, the chlorine was dried with every precaution, by passing it over a layer of phosphoric pentoxide 1 metre in length, &c. Experimental evidence appears to indicate beyond a doubt that to all appearance ("*Möglicherweise*" is the word Victor Meyer wishes at present to be used) by heating chlorine oxygen can be obtained. This being proved, then the splitting up of chlorine at a high temperature will give rise to the following probable theory :—If—



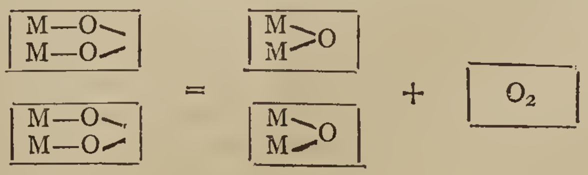
$$Cl = \begin{matrix} M—O\diagdown \\ M—O\diagup \end{matrix}$$

where M = Murium, then this atom or Cl, at the high temperature mentioned, yields—



$$O + \begin{matrix} M \\ M \end{matrix}\!\!>\!O,$$

and the molecule Cl - - - Cl is decomposed as follows :—



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* Report from notes taken at the meeting of the Chemical Society of Zürich, held Monday, July 21, 1879, during V. Meyer's lecture.

Thus ends the matter so far, but I need scarcely add that Victor Meyer's researches are continuing, and he is prosecuting them with unabated vigour, both in the directions of most stringent confirmation and further advance. For myself, since hearing of the discovery, I have thought much of and pondered over the wonderful relationship as to melting- and boiling-points calculated from the absolute zero, for the first time observed by Dr. T. Carnelly and W. C. Williams, of the Owens College, between chlorine, bromine, iodine, and sulphur, selenium, and tellurium (see Chemical News, vol. xxxix., p. 286). On consideration of this relationship, taken now in conjunction with Victor Meyer's great discovery, it seems to me very probable that all the six named, so-called, elements contain one and the same essence ("Gründstoff" is the more exact term in the German), and will be ultimately decomposed so as to yield this essence common to all six (Cl, Br, I, S, Se, and Te). This is not a hap-hazard "phantasie," but still further founded on, and suggested by, a consideration (combined with the foregoing one) of the analogy afforded by the melting- and boiling-points of the organic hydrocarbons and other carbon compounds arranged in certain series, viz., homologous, polymeric, and isomeric series.

These compound bodies contain a common so-called elementary body, carbon, combined with hydrogen in certain definite proportions, so that definitely constructed or ascending series may be arranged, in which melting-points and boiling-points are found also of definite arrangement, ascent or descent. In such compounds, too, the hydrogen may be replaced by the so-called elements, chlorine or bromine, and still furnish respective series of the kind named. The hydrogen in CH_4, too, may be considered replaced by sulphur, giving the compounds CH_2S and CS_2. Again, a mixed compound of S and Cl with C in the same molecule may be formed; *e.g.*, by the action of dry chlorine on carbon disulphide, $CS_2+Cl_4=SCl_2+CSCl_2$. Again, besides the combination of iodine with chlorine, a compound of iodine with sulphur is known, I_2S_2, also of bromine and sulphur. Of chlorine with sulphur two compounds occur, S_2Cl_2, boiling at 136° nearly, and SCl_2 boiling at 164°.

It does not seem, then, at all impossible that the chlorine group may furnish a kind of homologous, perhaps polymeric, series, and the sulphur group another homologous series, derivable from the first by some simple means, similar to those applicable in the hydrocarbon series. In other words, that a species of polymeric relationship possibly exists between the chlorine group members, and another and higher, more complicated, kind of polymerism connects this group with the sulphur group, and connects it intimately. To take a case of polymerism in a hydrocarbon group observing boiling-point relations, the group given by Schorlemmer in his "Chemistry of the Carbon Compounds" (p. 35) deserves notice. This group comprises the following:—

Acetylene, ...	$C_2\ H_2$	
Benzene	$C_6\ H_6$,	and adding boiling-pnts. $=353°$.
Styrolene, ...	$C_8\ H_8$,	reckoned above $-273°$ as zero $=419°$
Hydronaphthalene,	$C_{10}H_{10}$	$=487°$.

The ordinary homologous series with their gradually rising boiling-points are too well known to need further than mentioning.

Here it may be noticed that the boiling-point of styrolene is nearly the mean of those of the other two members, benzene and hydronaphthalene, standing next above and below it; just as in the case of chlorine, bromine, and iodine, whose boiling-points are respectively 240°, 318°, and 473° (reckoned above absolute zero by Carnelly and Williams). 318° for bromine is not very far from the mean between (Cl) 240° and (I) 473°, which is 356°. All this, of course, is a speculation intended to illustrate the line of analogy suggested by the comparisons mentioned; still future experimental research may show that there is truth in it, but the patient experimental work alone can give the means of clearing up the mist which at present seems to overhang the whole question. It has often required the exertions of a master-mind and a master-hand to convince men that *they really are in a mist*, and the researches of Victor Meyer have recently done much, one may indeed say *most*, to convince the world of chemists that their elemental atmosphere is by no means so clear or cloudless as they had once imagined; also that much requires yet to be done ere the clear truth-light shines down upon them with unsullied brightness and splendour.

ON MANURE PHOSPHATES.

By K. WALTER,
Chemical Engineer, Aurelais, Belgium.

(Concluded from page 38.)

To the third group, the phosphates which are quite or for the most part soluble in citrate of ammonia belong some few sorts of guano; those, for instance, which contain up to 30 per cent of their phosphoric acid soluble in citrate. There are also some few natural phosphates containing a few per cents of their phosphoric acid soluble in the citrate. Then the so-called retrograded superphosphates. I have had myself superphosphates in work which held in the beginning 11·5 per cent of phosphoric acid soluble in water; after three years they only contained 1·5 per cent of it. It is a great injustice against superphosphate manufacturers that in England as well as in Germany this retrograded phosphoric acid is counted worthless in the market; the more so since for more than ten years an exact process of analysis has been known which determines the difference between natural and retrograded phosphoric acid. There exist lots of superphosphates which contain, after four to five months' storing, one-tenth to one-sixth of their phosphoric acid formerly soluble in water in a retrograded state, which latter is soluble in citrate of ammonia. Different raw phosphates have not been employed up to the present time because of their property of forming superphosphates which retrograde. The precipitated phosphates originating from a well conducted manufactory chiefly belong to this group. Such a one has 85 to 95 per cent of its phosphoric acid soluble in the citrate; it has not, however, up to the present time been sold either in Germany or in England, at all events not at the price it is worth.

Toulie years ago proved, by very extensive experiments (see his work mentioned on page 37), that bibasic phosphate of lime (which is soluble in the citrate) has the same effect as superphosphate, even in poor sandy soil. Alas! neither the English or German agricultural chemists would credit this experience—and yet they were unable to give the slightest proof to the contrary. Even when Toulie's experiments were shown to be quite correct by their being repeated by Dr. Petermann, and after the latter officially announced (in the year 1877) that from January 1, 1878, in all phosphates coming under the control of the Belgian Agricultural Stations all phosphoric acid soluble in citrate of ammonia must be counted as assimilable and of the same value as soluble in water, not a hand in England or Germany was lifted to follow the praiseworthy example.

Likewise the trials of Grandeau* (manager of the Chemical Agricultural Station of Nancy, France), on a very extensive scale and repeated for several years, have proved that precipitated acts not only with the same speedy efficacy as superphosphates, but even with greater.

It is further shown, by the experiments of Petermann, that phosphate of iron and of alumina (soluble in citrate) are even far more efficient when employed as manure phosphates than even superphosphate and precipitated

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* "Annales de la Station Agronomique de l'Est, France," vol. ii. (See also *Biedermann's Centralblatt für Agricultur Chemie*, 1878, Band 2, Scite 650.)

phosphate of lime. Up to the present time it has been taken for granted by nearly all chemists that the process which takes place in some sorts of superphosphates, commonly called retrograding, is caused by oxides of iron and alumina, which form, with a part of the mono-basic phosphate of lime, bibasic phosphates of iron and alumina insoluble in water. Be it so, there is then an additional reason to value the retrograded phosphoric acid as not only equal but even higher than the superphosphate itself. If *superphosphate* comes into contact with the *soil* this process does not seem to take place, but rather that *tribasic* phosphate of lime, and perhaps of iron also, is formed. For if bibasic phosphate of iron and alumina is employed directly for manuring, the result is far more favourable than with precipitated phosphate (soluble in citrate), the result of this latter being already superior to that of superphosphate.

These are facts stated by different eminent agricultural chemists, and put to trial by the experience of years and years. It is not the case, however, that only bibasic phosphate of lime, iron, and alumina are soluble in citrate of ammonia, the tribasic are also soluble under certain circumstances. Nobody, I think, would be able to make a precipitate (dried at not over 100° Celsius), of which not always a certain portion is soluble in the citrate, at all events I myself never succeeded. On the contrary, it is very difficult to make a product which is thoroughly soluble in the citrate.

I have worked for three years at this subject, but I must confess the results obtained in the laboratory differ from those in the manufactory, a result which I cannot as yet explain. It would occupy too much space to enter into all the reactions which can occur in phosphate making. True it is that for the chemists the analysis after the citrate method is very tedious, but this is not a sufficient reason to suppress a progress made by science and proved by practice; and if the French and Belgian chemists were obliged to accommodate themselves to it, the English and German chemists will, sooner or later, be obliged to do the same.

The manufacture of precipitate is only carried on with advantage in places where muriatic acid, and at the same time mineral phosphate, are to be had at a very cheap rate. There are at present only two works existing in France, and more will hardly be erected, the muriatic acid having too great a value in France. One of these works is carried on with great success, being able to reckon (an exceptional case) the muriatic acid at an extremely cheap rate, and being in the neighbourhood of rich layers of phosphate containing very little iron, alumina, and carbonate. Besides this, the work is managed extremely well, having the advantage of the many years experience. The other work mentioned has not yet made a product sufficiently rich in phosphate soluble in citrate. This branch of manufacture is only remunerating when the product has at least nine-tenths of its phosphoric acid soluble in the citrate.

In Belgium there exists one work for manufacture of precipitate, erected by the writer. The delivery of muriatic acid at a cheap rate being assured for several years, and the raw phosphates being cheap enough, the work can be carried on with fair success. The raw phosphate is coprolites from the neighbouring French Ardennes, containing 35 to 40 per cent of phosphate of lime, and only 7 to 8 per cent of carbonate. The phosphate of Mons, which would be for here so very convenient, is, as mentioned already, not fit to be used for this manufacture; it wants more than double the quantity of muriatic acid for its decomposition than it ought to do for the manufacture to be profitable.

In most cases, phosphates which contain much phosphate of alumina and iron are also unfit for the manufacture. This is the reason why the work erected at Mühlheim on the Rhine, Germany, by an English company did not succeed. They intended to work Nassau phosphate, which is not fit for the manufacture—containing too much iron and leaving too much phosphoric acid in the residues; besides this, muriatic acid can be sold in Germany at a much higher rate than it could be employed with profit for the manufacture in question. Then, also, the management was not at all up to the task of making soluble phosphate. It is the problem of the precipitate manufacture to employ phosphates which are too poor for the superphosphate manufacture.

In Belgium and France the same rate is realised for the precipitate as for the superphosphate—0·80 fr. per kilogrm. of phosphoric acid, taken in large quantities; the former of course pays more. There is no doubt the time will come that good precipitate will be paid for at even a higher rate than superphosphate, if only on account of its richness, which renders it more fit for transportation to a distance. Already more than half the quantity produced is sent to the French and Dutch Colonies.

Superphosphate with 20 per cent of phosphoric acid is not easily to be found in the market, while precipitate can easily be made with 35 to 38 per cent of phosphoric acid. Because of its finer division it is also much better adapted for top-dressing (a method of manuring which in later years has been more and more employed), not to speak of its harmlessness: while superphosphate before decomposed by the soil is a poison to the young plants.

To work in the direction which Petermann and other agricultural chemists' results of experiments indicate, it would be very desirable to bring into the precipitate as much phosphate of iron and alumina as possible; but the technical difficulties have been up to the present too great. Not only are large quantities of phosphate of iron and alumina, insoluble in the citrate, formed in the process of precipitation, but precipitate with too much of the latter phosphate is, on account of its fine division, too difficult to work in the filters and presses. If a precipitate contains one-fourth of its phosphoric acid united to iron and alumina, this is the utmost obtainable until other means are found.

To the last of the four groups belong the superphosphates. They are manufactured of from 11 to 12 per cent of phosphoric acid soluble in water. One of less than 11 per cent is hardly to be found now in the market; and to make them richer than 22 per cent, and at the same time dry, will be also too costly. As mentioned already, in Belgium and in France the phosphoric acid soluble in water is no longer considered in the analysis; all that is soluble in citrate of ammonia is taken for soluble and immediately assimilable. It is my opinion the experiments of Dr. Petermann and others, at present going on, will prove evidence—as already, however, proved practically—that even certain phosphates, *not soluble in citrate of ammonia* are *just as speedily assimilable* as the before-mentioned.

Superphosphate is, strictly taken, a necessary evil. No one will be hardy enough to maintain that monobasic phosphate of lime (superphosphate) is assimilated by the plant as such; and every one who is experienced in the subject will agree that the superphosphate finds in the soil *more* carbonate of lime, oxides of iron and alumina, than necessary to transform it speedily into bibasic and tribasic phosphates. The two latter are, then, taken up and put into an assimilable state by the salts of ammonia, soda, potash, and the carbonic acid to be in such solution assimilated by the plants.

It is equally a great question if the arsenic brought into the soil by means of the superphosphate in the long run does not create an injurious action. Sulphuric acid employed for superphosphate making contains sometimes quite formidable quantities of arsenic, which in this manner is incorporated with the soil in a soluble state. However, natural phosphates acting mostly too slow, bones and guano not being available in the market in sufficient quantity or sufficiently cheap, and as advantageous means of producing sufficient quantities of lime, iron, and alumina phosphates are not yet known, the superphosphate will still, therefore command the market. The manufacture of precipitate will go on beside the superphosphate manufacture, like the soda-ammoniac process beside the old process of making soda-ash.

There is still a product to mention which is made in Germany, liquid phosphoric acid, sold in barrels, of course impure, and not free from monobasic lime and iron phosphate. It is used for certain mixed manures, which have to be comparatively rich in phosphoric acid.

GENERAL OUTLINE OF A NEW THEORY OF MOLECULAR SUBSTITUTION,

AS CONCEIVED AND ELABORATED FROM THE STANDPOINT OF THE "TYPO-NUCLEUS" THEORY.

By OTTO RICHTER, Ph.D.

In pondering the precise nature of the various molecular changes which accompany the process of substitution proper I was not long in satisfying myself that, over and above the method of reciprocal or two-sided transfer which characterises the ordinary process of double decomposition (Chemical News, vol. xxxix., p. 59), other modes of transmission were yet resorted to in nature's laboratory which had hitherto eluded the attention of chemists, either because the accompanying changes were strictly intramolecular, or because they consisted in the one-sided transfer of one single subjunct only. It is with the aid of these broader views and conceptions that I hope to succeed in expounding the true *modus operandi* of that wonderful species of mechanism which presides over this particular order of chemical phenomena. From an extensive series of researches on this subject I have, further, been led to conclude, that the said mechanism is indebted for its main source of motive power to the fundamental law of quantivalence or thermal bond-relationship, which again, for its proper manifestation, depends entirely on the support and co-operation of the fundamental law of multivalence or physical impact-relationship. The *nexus causalis* thus affirmed to exist between these three kinds of agencies naturally suggested to me the exact logical order in which the two laws just spoken of ought to be studied and discussed. The present communication bears the title :—

On the Fundamental Law of Multivalence or Physical Impact-Relationship.

In reflecting on the primary cause of those simple numerical relations which are found to obtain between the equivalent volumes and vapour-densities of aëriform bodies, I have at length been brought to recognise the general law which dominates this section of natural philosophy. The law in question, is regarded by me as the outcome of certain dynamic relations established between the elasticity, vapour-density, and heat-emitting energy of aëriform substances, and may be briefly enunciated as follows :—*Under the same conditions of temperature and pressure equal volumes of aëriform bodies, whatever their atomic weight and chemical composition may be, always contain an equal number of molecules.* Taking the reality of this law for granted my next duty will be to expound the fundamental law of multivalence, and to point out its intimate connection with the law of aëriform bodies just enunciated. In my opinion the law of multivalence is the outward manifestation of a powerful tendency inherent in all chemically simple bodies to undergo the process of self-condensation, in virtue of which two or more univalent molecules, $2E_2$, may by a species of physical impact become cemented together in such a way as to give rise to a series of progressively more complex, and specifically heavier molecules, for which I shall employ the terms—bivalent, trivalent, quadrivalent, &c. The class of molecules under consideration have, moreover, this characteristic feature in common, that they are capable of preserving the fundamental type originally impressed upon their parent molecules. In further illustration of this subject I shall now present the reader with a brief summary of such valuable experimental evidence as may be adduced in proof of the general soundness of this new doctrine of molecular self-condensation.

Commencing with the class of non-metallic elements we encounter in the highest member, $2S_{12}$ of the sulphur series, $2S_2$; $2S_4$; $2S_6$ . . . $2S_{12}$, a notable instance of self-condensing energy. To this molecule with a vapour-density six times greater than what by theory pertains to the first or parent molecule of the series, there became added afterwards a second modification, $2S_4$, which, by its vapour-density, is evidently pointing to the second member of the series. A similar series, $2O_2$; $2O_4$; $2O_6$, but of half the length only, is met with in the case of oxygen, the second member of which corresponds no doubt to the ordinary atmospheric variety, while the third member, so-called ozone, is a more recent discovery. Turning to the element nitrogen only one modification is familiarly known to us, but in striking contrast with the common practice I have good reason for identifying it with the second member, $2N_4(N_2=14)$, of the series. It is worthy of mention that, although the first or generating members of the three series before us have not yet been obtained in a state of isolation, they are, nevertheless, by common consent and from purely theoretical considerations only, believed to exist as such in a great variety of chemical combinations. Glancing, in the next place, at the class of metallic elements I shall select from among their more volatilisable members, first, the quasi-metallic element, phosphorus, the only known modification of which is by its vapour-density held to correspond to the fourth member, $2P_8$, of the series, while the lower members can be shown to exist as such in combination with sulphur, oxygen, and other non-metallic elements; secondly, the truly metallic element, mercury, which belongs to the rare class of metals, whose generating molecules in passing from the liquid into the aëriform state, so far from undergoing a process of self-condensation, are actually, to judge from their vapour-density, made to split up into two equal halves, so that in the case of mercury the resulting semivalent molecule will claim to be expressed by the symbol, $2Hg(Hg_2=400)$. We are now in our general survey brought face to face with hydrogen, the specifically highest and certainly the most remarkable of all the metallic elements. I will only observe here that in the free state hydrogen seems to be entirely destitute of the power of self-condensation, whereas after being combined with carbon, whereby it gives rise to the prolific family of the hydrocarbons, that same element appears to have acquired a degree of self-condensing energy which places it on a par with sulphur, carbon, and other elements.

Having now briefly explained to the reader the general import and significance of the law of multivalence as applied to chemically simple substances, whereby it gives rise to a number of variously extended series of derivatives, which have all of them this characteristic feature in common, that they are constructed on the fundamental type of principal nuclei, I shall in the next place consider the law of multivalence in connection with that class of chemical combinations which are formed by the direct union of the aforesaid principal nuclei with outer conjunct molecules (Chemical News, vol. xxxix., p. 48).

Confining my remarks to the four elements, carbon, sulphur, nitrogen, and oxygen, and to the first two series of derivatives, the following combinations have been selected and embodied in the annexed table of chemical formulæ.

In commenting on this scheme (next page) I may observe that the compounds before us belong each and all to the class of so called anhydrides, but although bearing a strong resemblance to each other in their general chemical character and deportment, I have satisfied myself that there exist certain important constitutional differences between them which it becomes incumbent upon me to

Table of Chemical Formulæ Representing Combinations of Principal Uni-orbivalent Nuclei with one Species of Outer Conjuncts.

	Univalent Nuclei.	Outer Conjuncts.				Bivalent Nuclei.	Outer Conjuncts.		
1st Series	$2C_2$	O_2 ; O_4	N_2	S_2 ; S_4	2nd Series	$2C_4$	O_2 ; O_4 ; O_6 ; O_8	N_2 ; N_4	S_2 ; S_4 ; S_6 ; S_8
	$2S_2$	O_2 ; O_4 ; O_6	N_2 ; N_4	vacat		$2S_4$	O_2 ; O_4 ; O_6 . . O_{12}	N_2 ; N_4 . . N_8	vacat
	$2N_2$	O_2 ; O_4	vacat	vacat		$2N_4$	O_2 ; O_4 ; O_6 . . O_{10}	vacat	vacat

point out. For this purpose I have bethought myself of dividing these anhydrides into two separate classes. Among the first class I shall include all those compounds whose outer conjuncts are composed of an even number of univalent sulphur, nitrogen, or oxygen molecules, and among the second class I shall include all those compounds whose outer conjuncts are composed of an uneven number of the aforesaid molecules. By this proceeding we are enabled to perceive at a glance the true reason why, as a general rule, the vapour-densities of the first class of molecules correspond to one-half only of their calculated value, while the vapour-densities of the second class correspond to the full amount of that value. Now, in my mode of viewing, the cause of this singular discrepancy must be sought in the circumstance that the univalent molecule of sulphur, nitrogen, and oxygen, and consequently also their multiples by an uneven number, stoutly refuse being split up into two equal halves, while their bivalent modifications seem to offer no formidable obstacle to that operation. On these premises we may readily trace the molecular changes which accompany, for instance, the splitting up of a molecule of anhydrous oxalic acid (dicarbo-trioxide), $2C_4O_6$, into a molecule of carboxide and a molecule of carbo-dioxide. Accordingly the first stage of the process, which requires the co-operation of two molecules of dicarbo-trioxide, will be marked by the transfer of a univalent molecule of oxygen from one molecule of the trioxide to the other, with formation of a molecule of dicarbo-dioxide, $2C_4O_4$, and a molecule of dicarbo-tetroxide, $2C_4O_8$, both of which, according to my theory, ought to be, as they are in fact, very prone to split up into two equal halves, namely, the former into two molecules of carboxide, $2C_2O_2$, and the latter into two molecules of carbo-dioxide, $2C_2O_4$. Applying our hypothesis to other combinations we can, further, understand why the vapour-density of hydroxide corresponds to the formula $2H_2O_2$, while the vapour-density of hydrochloride corresponds to the formula $2HCl$; for in either case the direct union of a univalent molecule of oxygen, on the one hand, and a univalent molecule of chlorine on the other hand, with a hydrogen nucleus gives rise first of all to the molecules $2H_2O_2$ and $2H_2Cl_2$, but owing to the circumstance that oxygen belongs to the class of indivisible elements, while both hydrogen and chlorine belong to the class of readily divisible elements, the final result will be that the molecule of hydroxide remains intact, while the molecule of hydrochloride splits up into two equal halves. In connection with this subject I may yet be permitted to dwell on the seemingly anomalous behaviour of certain compounds, which, from the bivalent character of their principal nuclei, as well as their outer conjuncts, ought to prove by their vapour-densities that in obedience to the general rule they have undergone the operation of splitting, whereas in reality no such change has taken place, or at all events not within the limits of a certain low temperature. The first of these exceptions is cyanogen, which, by its vapour-density, claims to be represented by the formula $2C_4N_4$; nevertheless, and although it is composed of a bivalent molecule of carbon and a bivalent molecule of nitrogen, our substance refuses to split up into two equal halves, even at a high temperature. But apart from this there can be no doubt, on the other hand, that the hypothetical semi-cyanogen with the formula $2C_2N_2$, does really exist as such in a vast number and diversity of organic compounds, as, for instance, in aceto-nitrile, $2H_3C_2$; $2C_2N_2$, where it is formed by the action of ammonia on hydric acetate. The second exception is nitrous acid, which exhibits a curious anomaly in this respect, that, below 82° F., it possesses a vapour-density corresponding to the formula $2N_4O_8$, while at a higher temperature it shows a vapour-density corresponding to the formula $2N_2O_4$, clearly proving thereby that the nitrous acid molecule has under the influence of heat been made to split up into two equal halves.

In the preceding pages it has been my endeavour to familiarise the reader with the most striking and characteristic features of the law of multivalence, and to demonstrate by a great variety of strong experimental evidence its intimate connection with the law of vapour-densities. I will only add in conclusion that in my treatment of the subject before us I have as much as possible confined myself to what I considered absolutely necessary for the proper comprehension of the fundamental law of quantivalence.

COAL-TAR COLOURS AND THE ELECTRIC LIGHT.

By Dr. GREIFF.

The author seeks to show that even in case the manufacture of gas were to cease, the supply of raw material for the production of artificial colours would not be imperilled.

In order to find a standard for the quantities of anthracen and benzol now required, it may be assumed that 30,000 kilos. of alizarin paste at 10 per cent are produced daily. The minimum quantity of pure anthracen needful would therefore be 3000 kilos. daily, or 900,000 kilos. per year. This necessitates the annual distillation of 360 million kilos. of tar, containing on an average $\frac{1}{4}$ per cent. of anthracen. The production of aniline amounts to 12,000 kilos. daily, requiring 13,300 kilos. benzol, and also obtained from the same 360 million kilos. of tar.

Future inventions will further heighten the importance of coal-tar so long as it is regarded as the sole source of the aromatic hydrocarbons.

But in case a partial scarcity of this substance should arise, we have firstly the proposal to obtain tar, not as a residue, but as a primary product by the dry distillation of coal, and to attempt the proportionate increase of its more valuable ingredients. A quantity of tar might be obtained by an improved construction of certain furnaces for metallurgical purposes, and of coke-ovens—for which, while the present ample supply is obtained from the gas-works, there is little inducement.

It is also possible that the worthless hydrocarbons in tar may be transformed into benzol and anthracen. The valuable products of coal-tar do not exceed 3 to 4 per cent, along with 30 to 40 per cent of oils, boiling at high temperatures, and of solids, a minority of which only are recognised as definite chemical individuals.

But there is a still simpler and easier method of obtaining aromatic hydrocarbons in more than sufficient quantity. Liebermann and Burg, Wichelhaus and Salzmann, and other chemists, have passed wood-tar and the tar of lignite through ignited tubes, and have invariably recognised the formation of aromatic hydrocarbons. These observations would have a mere scientific value did they not extend equally to the mineral oils of the Caspian and the tar—at present useless—which is obtained as by-product from their rectification. In order to decide this question we must consider whether the raw material is present in sufficient quantity; what is the yield of benzol and anthracen; and, finally, what is the cost of the process? All these points receive a favourable reply. Letny (*Dingler's Polytech. Journal*, 229, p. 353), shows that the product of crude mineral oil for the year 1875 was 240 million kilos.—a quantity easily susceptible of being greatly multiplied. After obtaining the luminous and the lubricating oils, more than one-half remains behind, and is partly used as fuel on board the steamers on the Wolga. Letny has decomposed this residue at a red heat and obtained from it a product, about one-third of the original weight of the tar, which yields 4·6 per cent benzol, 5·2 toluol, and 3·1 per cent of anthracen, and which can be worked far more easily than coal-tar, though yielding the same hydrocarbons in the same succession. The 120 million kilos. of tar represent, therefore, as far as the yield of valuable aromatic hydrocarbons is concerned, from 200 to 400 million kilos. of coal-tar. The production of petroleum on the Caspian is only in its infancy.

Similar results have not yet been actually obtained from the residues of American petroleum, but it is highly probable that they also will prove available sources of aromatic compounds. Hence should even the last gas-works in the world come to a close there is no reason to fear a deficiency in the supply of benzol and anthracen.—*Die Chemische Industrie.*

ON SOME WATER FROM THE RIVER DART WHICH DESTROYED FISH.

By Dr. T. L. PHIPSON, F.C.S., &c.

In my notes of some analyses of waters recently published in the Chemical News I have alluded to the importance of the indication furnished by *phosphoric acid* in the analysis of potable waters: I stated that, having tested a considerable number of spring and river waters for this substance, I had found it generally absent, and that when present it is undoubtedly a bad sign. When I wrote that Paper I had not access to the whole of my Laboratory memoranda, and I have since found in my notes of 1875-6 an examination of a specimen of water from the River Dart, taken at a portion of its course where it was found to be injurious to fish, and killed large numbers of trout.

Instead of yielding some 18 to 22 grains of total residue per gallon, as we might expect in an ordinary specimen of river water flowing through populous districts, it gave a very much worse result. I found this water *somewhat turbid*, and it showed a *slight* deposit of organic matter (vegetable *débris*, fragments of Algæ); it was *neutral* to test-paper. It gave—

Total residue, 52·50 grains per gallon imperial.

	Grains.
Nitrogenous organic matter, burning with a bad odour; nitric acid, and ammonia ..	17·50
Phosphoric acid	3·25
Mineral matters: carbonate of lime (chiefly silica, sulphate of lime, alkaline salts, &c...	31·75

The strata through which this water flows is the chalk of Kent. The presence of so much organic matter and that of phosphoric acid to so large an amount points either to sewage contamination or to refuse from chemical works finding its way into the river near the spot where this sample of water was taken. The former suggestion appears the most probable. This analysis was made in December, 1875; and in February, 1876, I examined a large trout that had died in this water. No poison could be detected in the stomach and intestines; strychnine and picrotoxine were more particularly sought for. The gas contained in the air-bladder, which was much distended, had a very foul odour (it is usually odourless, or nearly so); and at the commencement of the œsophagus I found a piece of printed paper, half swallowed and partially digested, bearing the date 24th November, 1875.

NOTICES OF BOOKS.

Elementary Lessons on Sound. By Dr. W. H. Stone, Lecturer on Physics at St. Thomas's Hospital. With Illustrations. London: Macmillan and Co. 1879.

The speciality of Dr. Stone's well-written Manual is the large amount of attention devoted to the consideration of the connection between acoustics and music; in fact there is no elementary work that we know of in which this branch of the subject is so well and fully treated. Beginning with the different methods by which sound is produced—whether by strings, rods, plates, bells, membranous reeds, columns of air, heat, or electricity—it gradually leads up to the modes by which it is propagated, its velocity, wave-motion, reflection, and refraction. Intensity, consonance, and interference are well described. The chapter on Pitch is also a good one, the various methods of tonometry being very clearly given. The mixed question of standard pitch is also lucidly described, as well as the courses which have led to the gradual rise in pitch that has taken place in European orchestras.

Chapter V. is devoted to the consideration of the nature of musical sounds as distinguished from mere noises; and Chapter VI. to the effects of heat, atmospheric pressure, moisture, and density on sound in general. The difficult questions of scales, chords, temperaments, and tuning are clearly treated. We see no mention in this chapter of the Oriental scale, which differs from ours, and cannot therefore be noted according to our notation, although Eastern melodies can be reproduced on a perfect instrument, such as the violin. It may be briefly mentioned that, owing to the intervals between all the notes except the first and second being different to ours, harmony is impossible except in octaves. The different attempts of Perronet Thompson, Pole, Bosanquet, and others to produce instruments with perfect temperaments are fully described and illustrated, as well as Mr. H. Bassett's ingenious comma and telephonic trumpets, in which perfect intonation is very closely approached.

An excellent description of the different kinds of musical instruments, and the principles upon which they act, is given in Chapter VIII. In this chapter there is a very clear and succinct description of the mechanism of the human ear, which the author very properly treats as a musical instrument. The same remarks apply to the description of the organs of the human voice.

The illustrations, of which there are nearly seventy, are generally good, but many of them seem to be badly over-printed, and some are from worn-out or damaged blocks. When will our English scientific publishers take a leaf out of the books of our American brethren in this respect? They are completely distancing us in the art of wood engraving as applied to scientific illustration, as any one may see by opening the "Scientific American," or any similar paper published on the other side of the Atlantic.

We should have been glad to see a fuller description of the telephone, microphone, and their congeners. In a work on Sound published in 1879 they surely deserved a better fate than being dismissed with exactly nine lines of mention. Prof. Tyndall's researches on the reflection of sound from layers of different temperatures also deserved fuller treatment. The phonograph, too, is dismissed in five lines, and Captain Galton's is not even mentioned, at least as far as we could discover.

With the exception of the woodcuts the book is well and clearly printed, and the frequent side-headings will be a great convenience. Beyond the few defects we have pointed out we have no reason to say anything but in praise of Dr. Stone's little book, except that the index is a miracle of meagreness, and ought to bring down on his head the major anathema of the Index Society. Nevertheless we heartily recommend his book not merely to the science student, but to the musician who really wishes to be instructed in the scientific principles of the glorious art he practises.

CORRESPONDENCE.

TESTING COMMERCIAL POTASH.

To the Editor of the Chemical News.

Sir,—Some information recently gathered personally in the United States and Canada as to the commercial potashes produced there will, I think, be of interest to many of your readers. Being the managing director of a concern producing caustic potash free from soda, the subject naturally was one of great interest to me.

I visited the Montreal potash warehouses—a special warehouse where all the potashes produced in Canada are taken to be officially examined, tested, and branded, according to their quality as "firsts," "seconds," or "thirds." I was told that the system of examination and testing employed was most complete, and that the official branding here of quality was universally accepted without question. The inspector informed me that he first inspected the general condition of the casks; that they were thnen opened and the contents examined for colour and appearance, and a carefully drawn average sample taken to ascertain the amount of potash they contained; that this was most exactly ascertained and calculated by a standard solution of sulphuric acid and litmus paper! On gently hinting to the official inspector that this was hardly a satisfactory manner of procedure, and that the only accurate way would be by also ascertaining the actual potash contents in the usual way by the platinum method, I was astonished to find that he was quite ignorant of the difference between the two alkalies, potash and soda!

It will be manifest to all your readers that there is nothing to hinder adulteration with soda-ash to almost any extent, and that that the potash will pass the inspection perfectly—a good 58 per cent soda-ash fused with the potash would easily come out as a "potash" of 78 per cent. Soda-ash is now worth in Montreal about £8 per ton, potash about £20 per ton, so that this source of profit will doubtless be availed of by enterprising producers of wood-ashes up in the country.

In New York and Philadelphia there is no official inspection, and out of the many consumers of wood-ashes that I saw and talked with in these districts, I only met one who actually tested his ashes for potash contents. There was a general complaint, however, that "somehow" their production was often unaccountably short or unsatisfactory, even though the ashes contained a full strength of potash according to the alkalimeter. The reason I think of this is very evident.—I am, &c.,

W. J. Menzies,
Managing Director Greenbank Alkali Works Co.

St. Helens, Lancashire, July 23, 1879.

CHRONOLOGY OF THE ISOMERIC PURPURINS.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xxxix., p. 255, I find an article on the above subject in supplement to which I beg to say the following.

In December, 1871, Dr. Gessert of Elberfeld forwarded to Prof. E. Kopp, of the Technical Laboratory at Zürich, a bottle, labelled "artificial purpurin," and requesting thorough researches as so the nature of the "purpurins" contained in the substance. Dr. E. Kopp entrusted me with the working out of the subject in question. The consequent investigations led to the method described by me in the *Moniteur Scientifique*, and it is in the same paper that the name of isopurpurin was given to the product separated from the original paste by my process. The investigations were published in March, 1872, and the results forwarded to Dr. Gessert, Prof. E. Kopp promising me at the same time to fully report the matter in the *Moniteur Scientifique.* I am unable to say why the publication was delayed from March to August, but it is highly probable that technical reasons were the cause.

Mr. Perkin's first preliminary publication of 1870 had not come to my knowledge at that time, and when the second preliminary report of 1872 appeared, my paper was already concluded. The full description of anthrapurpurin, however, only was brought out in 1873, fully a year after my paper on isopurpurin.

Regarding the pure state of iso- and anthra-purpurin at the time of their description (1872 and 1873), later researches in both the subjects have shown that neither of the bodies described in the original reports (1872, iso-, and 1873, anthra-purpurin) were the chemically pure ones. As to the isopurpurin, Prof. Morton has taken trouble in fully showing its having been a mixture in 1872, and, in fact, only in 1876 Messrs. Schunck and Roemer succeeded in obtaining this body in a pure state. The same chemists, however, find that the original anthrapurpurin of Perkin was by no means a pure body, and came to the conclusion that just the fact of its having been impure led to the error of its being "sparingly soluble in alcohol," the very quality forming the main difference between the iso- and anthra-purpurin. Messrs. Schunck and Roemer found the pure anthra-purpurin "easily soluble in boiling alcohol," (*Ber. der Deut.*, 1877, p. 680) and a foot-note says:—"Mr. Perkin describes his anthra-purpurin as sparingly soluble in alcohol and we found the same with a sample received from this gentleman. Probably this depends upon small quantities of impurities contained in the anthra-purpurin, and for this view speak the results of the analysis, and the small ability for crystallisation of the product, which is almost amorphous."

The above will easily show that the iso- and anthrapurpurin could not both claim the name of pure bodies at the same time of their original description, and that the investigation of both bodies had been made at same time, independently from each other.—I am, &c.,

J. Auerbach.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 1, July 7, 1879.

Identity of Bacillus Amylobacter and of the Butyric Vibrio of M. Pasteur.—P. Van Tieghem.—The author contests the identity of these organisms, which had been asserted by Prazmowski, of Leipzig. The details of the paper are micro-botanical rather than chemical.

Evaporation of Water under the Influence of Solar Radiations which have Traversed Coloured Glasses.—A. Baudrimont.—It appears from the facts described that coloured glasses exercise a real influence upon the evaporation of water, and that the quantity vaporised varies with the nature of the colours. Green and red are in general the colours least favourable to evaporation. Their relative activity fluctuated. Yellow and colourless glasses were the most favourable. In the experiments of 1859 blue and orange, which are complementary colours, were almost equal in action. The water of the basin of Arcachon presented the singularity that colourless glass was scarcely more active than green glass and was far surpassed by red glass. Red glass, which allows a slight evaporation of water is the one whose colour is extinguished by the smallest photometric thickness, whilst yellow and colourless glass let more light pass and produce the greatest evaporation. Green is often inferior to red in its action, although it transmits a greater quantity of light. The explanation of these phenomena is not readily found. Does heat alone undergo a kind of analysis under coloured glasses, as is the case with light? Is coloured light ultimately transformed into heat? The author has long been of opinion that heat is essentially distinct from light, being due to a movement of the molecules, and not of their constituent elements, as is the case with light; the vibrations producing it are larger and less numerous in an equal time, and are propagated with less speed.

Thermo-chemical Study of the Alkaline Sulphides.—P. Sabatier.—The author describes the heats of formation and of hydratation of the anhydrous sulphide of sodium, of the hydrosulphide of sodium sulphide, and of the corresponding potassium compounds.

A New Metal Discovered by M. Telleff Dahll.—An account of the discovery and principal properties of Norwegium. (See Chemical News, vol. xl., p. 25).

Commercial Trimethylamin.—E. Duvillier and A. Buisine.—Commercial trimethylamin is not, as M. Vincent considers, a simple product, but a very complex mixture, containing only from 5 to 10 per cent of trimethylamin, about 50 per cent of dimethylamin, besides mono-methylamin, mono-propylamin, and mono-isobutylamin.

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. June, 1879.

Studies on Tempering Glass.—Dr. Schott.—An elaborate account of all the methods proposed for tempering glass. The paper does not admit of useful abstraction and its re-production is specially prohibited.

Report on Dephosphorising Steel by the Process of Thomas and Gilchrist, and Proceedings of the Iron and Steel Institute for May 7, 8, and 9, 1879.—The author considers that though the process has not advanced beyond the experimental stage it is still important to have shown that under certain conditions phosphorus can be eliminated in the Bessemer converter.

Aniline-black.—Dr. Hæussermann.—Referring to Dr. Kayser's paper, the author remarks that for the last ten years anilines containing mere traces of toluydin have been exclusively used in the production of aniline-blacks.

Bulletin de la Société Chimique de Paris, No. 12, June 15, 1879.

Preparation of Methyl-formic Ether and of Pure Methylic Alcohol.—C. Bardy and L. Bordet.—The authors prepare the former compound by placing in a flask formiate of soda, dried at 130° to 140°, and powdered, to which is added at once a mixture of methylic alcohol and hydrochloric acid, the three substances being in equivalent proportions, with a slight excess of methylic alcohol. To the neck of the flask is fitted a worm surrounded with cold water, which is not renewed. Above the worm is a delivery-tube, which leads the vapours into a second worm kept carefully cooled. The flask is plunged in cold water, which is gently heated to a boil. When the water surrounding the first worm rises to 45° the operation is complete. In this manner, from 2 kilos. sodium formiate, the authors have obtained 1610 grms. pure formic ether, the theoretical yield being 1764. The ether is easily saponified by means of a solution of caustic soda at 30°, the exact standard of which is known, equivalent quantities being taken.

Pseudo-uric Acid.—E. Grimaux.—If uramile reacted upon urea with elimination of water and ammonia there would be formed a body of the composition of uric acid. Elimination of ammonia, however, alone took place, and the pseudo-uric acid of Baeyer was formed.

New Method of Formation of Glycocoll by means of Nitracetic Ether.—M. de Forcrand.—It appears from the researches of Meyer and Stüber that the hydrobromic and hydriodic ethers of the fatty series if heated with silver nitrite give rise to isomeric nitric ethers, which on reduction yield alkalies. The author has applied the same reaction to the brom-hydric ether of glycocolic acid.

Action of Ethylen upon Benzol in Presence of Aluminium Chloride.—M. Balsohn.—Among the substances formed are ethyl-benzin, diethyl-benzin, and triethyl-benzin.

Active Principle of Insect Powder.—G. Dal Sie.—This powder is obtained from species of Pyrethrum, of different origin. In 1876, Jousset de Bellesme extracted from *P. carneum* an alkaloid. In 1878, M. Rother discovered an acid, or rather a glucoside, possessing insecticide properties. The author has obtained from the ethereal extract a crystalline acid, and from the alcoholic extract a resinous matter, which in contact with dilute sulphuric acid splits up into sugar and another product.

Moniteur Scientifique, Quesneville. July, 1879.

Periodic Law of the Chemical Elements.—D. Mendeleeff.—From *Liebig's Annalen*, 1872.

Notices of Foreign Researches.—E. Noelting.—These notes consist entirely of extracts from the *Berichte der Deutsch. Chem. Gesellschaft.*

Medical Properties of the Salicylate of Soda.—A lengthy discussion on the value of the salicylates in the treatment of gout and rheumatism.

Studies on Ultramarine.—T. Morels.—The composition of natural ultramarine is by no means constant. The carbonate of lime found in it by Gmelin to the extent of 28 per cent belongs to the gangue in which the lazulite is embedded. Natural ultramarine does not resist alum and acids, but is decomposed by them with liberation of hydrogen sulphide often more readily than are artificial samples. There is consequently no means of distinguishing the natural from the factitious product. Dilute acids decompose artificial ultramarine with the evolution of sulphuretted hydrogen and sulphurous acid. The rose-coloured kind give off sulphurous acid alone. Concentrated sulphuric acid is without action. Hot concentrated solutions of caustic alkalies turn the colour from blue to grey. Saturated solutions of alum decompose ultramarine slowly in the cold, but more rapidly with the aid of heat. At about 200° it is converted by acids into a violet ultramarine, which finally becomes red. Ultramarine may be heated to redness without being decolourised, and with certain precautions it may even be incorporated in melted glass, but it begins to be affected at 120° and becomes less brilliant. The complete analysis of ultramarine is very laborious. The author gives here a process sufficient for the requirements of the manufacturer, and showing the silica, alumina, total sulphur, and soda. The sample is first decomposed by fuming nitric acid. No sulphuretted hydrogen escapes, and the total sulphur remains in the liquid as sulphuric acid. The liquid is evaporated to dryness, the residue is taken up in a little water acidulated with hydrochloric acid, evaporated a second time, again dissolved in acidulated water, and the silica remaining undissolved is washed with cold water upon the filter. In the filtrate the sulphuric acid is precipitated with barium chloride, when the weight of the barium sulphate shows the total weight of combined sulphur in the ultramarine. Alumina is then precipitated by ammonia, and in its filtrate, after removing baryta by means of sulphuric acid, the soda is determined as sulphate. The properties required by consumers of ultramarine are a deep and brilliant colour, fineness, tinctorial power, and resistance to alum and to acids. All these points are determined by comparative trials with a standard specimen. Papers or textile materials tinted with aniline-blues on exposure to the sun are bleached often in a few hours. No other blue employed for this purpose fades so rapidly. Papers, &c., tinted with ultramarine or with cobalt, leave a blue ash on incineration. If ultramarine has been used the ash is decolourised by the application of dilute acids, whilst the shade of cobalt, on the contrary, is brightened by this treatment. Papers, &c., blued with prussian blue, yield on ignition an ash which gives the reactions of iron.

On Uralium, a New Metal of the Platinum Group. A. Guyard.—As far back as 1869 the author discovered this metal in commercial platinum obtained from Russian ores. Next to silver it is the whitest metal known; its malleability is as great as that of the purest platinum, but its ductility is much greater, and it is almost as soft as lead. Its melting-point lies near to that of platinum, and it is not volatile. Its sp. gr. = 20·25, and its molecular volume, like those of osmium, platinum, and palladium, is 6·25. Its atomic weight has been found 187·25. In its chemical properties it is difficult to distinguish from platinum.

Flour mixed with Mineral Substances.—C. Cailletet.—The author's method for detecting the tenth of a milligrm. of alum, magnesia, chalk, gypsum, arsenious acid, &c., added to 10 grms. of flour, depends on the insolubility of the flour of wheat, rye, barley, &c., in chloroform; on their specific gravity, which is less than that of chloroform, and on the specific gravity of the mineral matters, which exceeds that of chloroform. He takes a perfectly dry glass tube 20 centimetres in height, and 2 to 3 in diameter. 10 grms. of the flour are introduced, the tube is nearly filled with chloroform, corked, and shaken for a minute. It is then let stand in an upright position, and in a cool place for some time. The flour which floats on the surface is removed, the chloroform is decanted off and may serve for new operations, and the deposit is treated with cold distilled water, which dissolves alum. The substances insoluble in water are collected on a filter, dried, weighed, and examined physically and chemically. Mineral salts existing naturally in the flour are not deposited, but remain in the floating layer.

M. Chevreul, now in his 93rd year, began his usual course of lectures on organic chemistry at the Museum of Natural History on June 10th.

Chemiker Zeitung.

No. 28, July 10, 1879.

According to Dr. F. Brockhoff a solution of magnesium chloride is found preferable to water for filling gas-metres. There is no appreciable loss by evaporation, freezing is practically impossible, and the gas is freed from ammonia.

The stearin manufacturers of Paris and its district, who represent one-third of the production of candles in France and employ 6000 men, have petitioned for the abolition of the duty upon candles.

Antiseptic Action of Acids.—According to Sieber a relatively small proportion of acid, 0·5 per cent, prevents putrefaction. This property is conspicuous in the mineral acid, and in acetic acid. Lactic and boric acids are much less effective.—*Journ. Prakt. Chemie.*

Chinese Galls.—A new kind of Chinese galls have been lately introduced. They are of the size of a plum, bent over at the point, and contain 72 per cent of tannin. —*Arch. Pharm.*, ii., 724.

Benzol and Benzin.—These names have generally been regarded as synonymous, but certain pharmaceutical works now apply the name benzin to a light petroleum product. True benzol is soluble in half to three-quarters its weight of alcohol, while the petroleum spirit requires six times its weight.—*Arch. Pharm.*, ii., 519.

Acid Reaction of Flowers.—It is not correct to assert that the juices of red flowers have always an acid reaction, whilst those of blue flowers react neutral or faintly alkaline. Vogel has shown that many blue flowers have an acid reaction. The red flowers of *Pisum sativum* are neutral.—*Akad. Wissen. Munich.*

No. 29, July 17, 1879.

The "new burette" constructed by Dr. Lagrange seems according to the description to differ little from that of Binks. It is bifurcate above, the wider aperture serving for the introduction of the solution, which is then dropped from the narrower orifice.

Revue Universelle des Mines, de la Metallurgie, &c.,

Tome 5, No. 2, March and April, 1879.

This issue contains no chemical matter save what is taken from the *Comptes Rendus.*

Les Mondes, Revue Hebdomadaire des Sciences.

No. 11, July 10, 1879.

Falsified Autographs.—The chief difficulty in the way of the ingenious forgers of such documents lies in the ink, which cannot be brought to exhibit the irregular fading of genuine ancient writings.

Curious Behaviour of Lightning.—A house in the Avenue de Clichy was struck by lightning, which followed a water-pipe to the earth and then re-ascended to the fourth story.

No. 12, July 17, 1879.

This issue contains no original chemical matter. There is a curious account of the visit of M. Moigno to Rome for the purpose of obtaining the papal benediction upon his "Splendeurs de la Foi."

Reimann's Färber Zeitung,

No. 27, 1879.

The Rhenish papers announce the death of a girl from blood-poisoning, due to the alleged action of dyed stockings. Dr. Reimann points out that this case, like others of the class, is strictly anonymous, and without any guarantee of its authenticity.

La Correspondance Scientifique.

July 15, 1879.

Speed of Electric Currents.—According to the recent investigations of M. Siemens, described in the *Industrie Blätter*, the speed of an electric current, under the circumstances of the experiment, is 30·2 geographical miles per second, or about 40 kilometres.

Biedermann's Central-blatt.

June, 1879.

The Reverted Phosphoric Acid in Superphosphates.—Prof. A. Millot.—It is supposed that those phosphates are most important for the nourishment of plants which are soluble in water containing carbonic acid. The attempt has been made to determine their value according to their solubility in the citrate and the oxalate of ammonia. The action of these reagents is discordant. Certain aluminous and ferriferous phosphates dissolve very readily in the citrate of ammonia, but sparingly in the oxalate, whilst other phosphates behave in the inverse manner. These tests would lead us to assign a higher value to the phosphates of iron and alumina than to dibasic phosphate of lime. To determine the value of a superphosphate the author finds, first, the proportion of phosphoric acid soluble in water; secondly, the phosphoric acid soluble in acetic acid (from which that soluble in water is deducted), representing the bibasic phosphate of lime; lastly, determination of the phosphoric acid soluble in a cold ammoniacal solution of citrate of ammonia, from which again the two former quantities are subtracted. The author finds that the presence of ammoniacal salts prevents to a great extent the reversion of soluble phosphates.

Absorption of Mineral Matter by Plants.—P. Dehérain.—Plants whose roots are placed in a solution of sodium chloride, either unmixed or accompanied by small quantities only of potassium and calcium chlorides, absorb sodium in smaller proportion the more of the other salts is present.

On Schizomycetic Fermentation.—Dr. A. Fitz.—In the warm indigo-vat the indigotin is reduced by hydrogen liberated by fermentation. No trustworthy statements are to be found concerning the nature of the organism which excites the fermentation, but it is probably *Bacillus subtilis*. The liquid is first heated to a boil, then cooled down to 104° F., and kept at that temperature, exactly as if the propagation of *Bacillus subtilis* was intended.

Action of the Milky Juice of Carica Papaya.—Dr. L. Wittmak.—The author proves experimentally that the juice of this tree is (or contains) a ferment that acts energetically upon nitrogenous bodies, and, like pepsin, coagulates milk. Its action is more rapid than that of pepsin, and is not arrested by temperatures of 60° to 65°. If boiled it yields a precipitate, as also, on the addition of mercuric chloride, iodine and the stronger mineral acids.—*Naturforscher.*

Justus Liebig's Annalen der Chemie, Band 197, Heft 3.

Communications from the Chemical Laboratory at Griefswald.—These consist of a memoir by Dr. L. Spiegelberg, on Nitro-, Amido-, and Bromo-sulphobenzolic Acids, with a description of many of their Salts; and a memoir by Dr. Heinzelmann and Dr. Spiegelberg, on Pentabrom-sulpho-benzolic Acid.

Action of Dehydrating Agents upon Camphoric Acid and its Amides.—M. Ballo.—The author's object was to obtain the nitrile of camphoric acid, which agrees in its empirical composition with nicotin. He obtained a small quantity of a nitrile, $C_{10}H_{14}N_2$, a colourless crystalline body which in a state of absolute purity would probably be inodorous. It is insoluble in water, soluble in ether and alcohol, and sublimes between 125° and 130° without melting. It is apparently saponified on boiling with potassa.

MISCELLANEOUS.

The Rare Metals.—Dr. Theodor Schuchardt, of Goerlitz, sends us the following quotations for the rare metals to which we directed attention in our issue of the 18th ult.:—Cerium, 20s. per gramme; lanthanum, 40s. per gramme; and didymium, 30s. per gramme. These are obtained in globules by electrolysis. Thorium, in powder, is 36s. per gramme.

A Visit to Mr. Edison's Laboratory and Works.—Mr. W. Lant Carpenter has kindly sent us a copy of a letter to the *Bristol Mercury*, in which he gives an account of a visit to Mr. Edison, at Menlo Park. The following is an abstract of the letter:—The laboratory, workshops, &c., as well as some isolated buildings, for delicate electrical measurements, are spread over an acre of ground, railed in, admission to which is only given to privileged visitors. The machinery is driven by a beautiful, high-pressure, 80-horse engine, also used to drive the electric light machinery, most of which is in the same shop. About a dozen workmen were engaged, some in electrical test measurements, &c., but chiefly in manufacturing Mr. Edison's latest form of telephone, constructed for the electric and hygrometric conditions of our English atmosphere. About 50 of these have already been sent to the Edison Telephone Company, No. 6, Lombard Street, London. Their price in New York is 14 dollars per pair, or about £2 15s. The same instrument contains a mouth-piece for the transmitter, and a vibrating disc as a receiver, about 3½ inches diameter, from which the sound comes out loud enough to be heard all over the room. In this instrument the carbon button of the old Edison telephone is replaced by a cylinder of strongly compressed chalk, rendered a conductor by being moistened with a solution of, it is believed, phosphate of soda. A weak battery current is used in this, as in the other Edison telephones, the intensity of which is varied by the voice acting in some unexplained way upon the chalk conductor. Mr. Edison admitted that he was not doing very much at present at the problem of domestic electric lighting. He appeared to consider the question of its economical sub-division a solved problem (he had 16 lamps in the workshop, each with its small coil of platinum wire, in a glass globe, 3 or 4 inches diameter), and was now giving attention to the details of lamp construction. This new form of lamp is to be a minute cylinder of compressed pure zircon, which is to be heated to whiteness by the surrounding coil of platino-iridium wire. A chemist was engaged in purifying zircon for this purpose. There were only two electric light machines in the shop—one a discarded American instrument, the other Mr. Edison's own invention, apparently very simple, but giving a current in one direction only, not the rapidly alternating currents given by most machines. The newest thing in the shop was a dynamometer, the last and best of several invented by Mr. Edison, with the result of which he was perfectly satisfied, and he stated that with this instrument he had been able to show that, after deducting the necessary amount for friction in the machinery, more than 95 per cent of the mechanical force employed was obtained in the form of light. Time did not permit us to go through all the steps of the demonstration, which he ended by saying, "and, therefore, this is the most perfect machine in existence." As far as could be seen there appeared to be some fallacy (1) in the expression of mechanical force in terms of electricity, or *vice versa*; or (2) in the expression of light-intensity in terms of electricity, or *vice versa*. The principle adopted in the dynamometer is that of the sustaining motion which keeps a weight-driven clock going while it is being wound up. Upon the belt which drives the machine is placed a loose pulley, to which is hung a box, containing 1000 lbs. of iron. The belt is thus pulled down in the centre. The box is placed upon a weighing machine, and in normal conditions weighs 1000 lbs. When an additional resistance is put on, as by working an electric light machine, the weight of this box is altered, and from the amount of this alteration, and the known speed of the belt, the desired results are calculated. Mr. Carpenter also informs us that in consequence of enquiries by circular addressed to miners in Colorado (whence he has just returned) and elsewhere by Mr. Edison, platinum is found to be much more extensively distributed out there than was supposed.

THE CHEMICAL NEWS.

Vol. XL. No. 1028.

GREEN PIGMENT FROM CHROMATE OF BARIUM.

By THOS. DOUGLAS.

Barium chromate, which precipitates on the addition of a solution of barium chloride to a solution of a soluble chromate, is used to some extent as a pigment under the name of "lemon-yellow." When strong sulphuric acid is added to this substance in the dry state great heat is developed, and it is coloured a deep red from the liberation of chromic acid. If the mixture be now ground up in a mortar and heated to bright redness, the chromic acid is decomposed into the sesquioxide, which colours the mass green, yielding a pigment possessing considerable body. Assuming the reaction to be—

$$BaCrO_4 + H_2SO_4 = BaSO_4 + H_2CrO_4,$$

the amount of sulphuric acid requisite for the complete decomposition of barium chromate is 38·7 per cent. It is not advisable, however, to decompose the chromate completely; this would dilute the pigment too much with barium sulphate; and, besides, the presence of a certain proportion of the yellow element seems to improve the quality of the colour. Very good results are obtained by using 20 per cent of sulphuric acid (o.v.)

From the great heat developed it might be rather dangerous to mix the dried chromate with strong sulphuric acid on a large scale. The better method of proceeding would probably be to mix the wet precipitate with acid of ordinary strength, and dry the mixture at a moderate temperature. In this way the chromic acid would be thoroughly incorporated with the other substances.

The pigment produced by the above process would doubtless possess great permanence and freedom from the objections arsenical greens are liable to. The cost of production ought to be moderate.

Manure Works, Blaydon-on-Tyne.

TRANSFERRING LIGHTFOOT-BLACK FROM ONE FIBRE TO ANOTHER.

By JUSTUS WOLFF.

Lightfoot-black dissolves in a strong solution of aniline hydrochloride in water, but not completely, with a deep greenish black colouration. The solution obtained in that way added to hot water dissolves with black violet colour, and this liquid dyes cotton, wool, and silk grey. Even the Lightfoot-black on the fibre dissolves in a strong solution of aniline hydrochloride (produced by mixing 12 parts of hydrochloric acid of commerce and 10 parts of aniline).

About three years ago I dyed a large quantity of China-grass yarn with Lightfoot-black by soaking the yarn thoroughly in a strong solution of aniline hydrochloride and potassium chlorate, greening for about a week, and then passing through a bath containing small quantities of chrome and hydrochloric acid, washing, and drying. A small quantity of that yarn treated lately with a strong solution of aniline hydrochloride produced a dark greenish black solution, whilst the remaining fibre, after washing and drying, showed a dark greenish grey colour. (Of course the fibre was corroded by the action of the aniline salt. The greenish black solution mixed with water dyed cotton a beautiful bluish grey, and wool and silk a blackish grey, all standing soap very well, that on cotton even improving by treatment with soap. We see here that this colouring matter has by itself a very great affinity for the fibres, without being produced on the fibre as in the Lightfoot process.

The shades thus produced on wool and silk are not bright, proving that the Lightfoot black process is unable to produce fine black shades at all on these animal fibres. The solutions obtained in the above manner contain too much acid and comparatively small quantities of colouring matter, so that it is very difficult to dye a deep black with. As far as I know, this is the first case of transferring Lightfoot-black from one fibre to another.

If the solution of Lightfoot-black in aniline salt solution is neutralised with caustic soda, diluted with water, and boiled till all the aniline is driven off by the water vapours, a greyish black powder remains in a light brown coloured slightly alkaline liquid. The powder filtered from the liquid, and washed on the filter with boiling water, consists of two different colouring matters, the one dissolving in boiling water acidulated with hydrochloric acid with a bright red colour, dyeing cotton and wool of a dull red shade, which by washing with clear water turns reddish brown, and by soaping clear brown, and the other consisting of a dark blue-black powder, insoluble in neutral and acidulated water.

Here we have another proof that the Lightfoot-black consists of two colouring matters—a dark blue and a brown one.

Wigan, July 30, 1879.

ON THE

EXPLOSION OF THE FLOURING MILLS AT MINNEAPOLIS, MINNESOTA, MAY 2, 1878, AND THE CAUSES OF THE SAME.

By S. F. PECKHAM.

As I was sitting at the tea-table on the evening of May 2, I was startled by a noise that sounded as if something as heavy as a barrel of flour had been tipped over on the floor above. A few seconds later the sound was repeated, and we all ran to the door which commanded a full view of the falls and manufacturing portion of the city. An immense volume of black smoke enveloped the spot where the Washburn A Mill had stood, and a perpendicular column of smoke was projected into the air above the elevator at least four hundred feet. The Humboldt and Diamond Mills were directly behind the elevator from the place where I stood. A heavy wind was blowing from a point a little to the east of north, a direction from the Washburn A Mill towards the elevator and the other two mills. In less than two minutes from the time of the first explosion, the elevator, which was 108 feet high, was wrapped in flames from top to bottom. If the structure had been saturated in oil the flames could not have spread much more rapidly. In five minutes flame and smoke were pouring from every window in the Day and Rollins, Zenith and Galaxy Mills, which were between the Washburn A Mill and the river, producing a conflagration which from ordinary causes would not have gained such headway in two hours. Six flouring mills, the elevator, a machine shop, blacksmith's shop and planing mill, with a number of empty and loaded cars, were in flames in five minutes from the time fire was first observed by any one who survived the disaster.

From my own point of observation, which was about a mile distant, but two distinct explosions were heard; others nearer heard three, the first not as violent as the other two; while those nearer still heard in addition a sound which they described as a succession of sharp hisses, resembling the sound of burning gunpowder.

Those observers to the windward whose attention was arrested by the light produced, beyond the distance of half a mile, heard only one or two reports or failed to hear any report at all. From all the testimony in reference to sound it appears that the blow upon the air was not sufficiently sudden to produce a penetrating sound, but rather a dull, heavy blow, which was not communicated laterally to any great distance.

Burning wheat or flour was smelled for several minutes before the explosion by persons in such a position that the wind would carry the odour to them. Smoke was also seen issuing from what was known as the exhaust flour-dust spout of the Washburn A Mill for several minutes preceding the explosion.

At the instant the explosion occurred all observers agreed that the Washburn A Mill was brilliantly illuminated from basement to attic. The illumination was reflected from the water at and around the falls in such a manner as to remind one observer of the effect of a brilliant sunset. Another compared it to the reflection of sunlight from windows when the sun is near the horizon. Still another, who was crossing the lower bridge, had his attention called to what appeared to be a stream of fire, which as he described it, issued from a basement window and went back again. Immediately thereafter each floor above the basement became brilliantly illuminated, the light appearing simultaneously at all the windows, only an appreciable interval of time intervening as the stories ignited one after the other. Then the windows burst out, the walls cracked between the windows and fell, and the roof was projected into the air, followed by an immense volume of smoke and flame which ascended to an estimated height of from six to eight hundred feet. As the column of smoke was expanded and borne off upon the wind, brilliant flashes resembling lightning passed to and fro.

Two men, so near the Humboldt Mill that they were nearly buried by the falling rubbish, and on the opposite side from the Washburn A Mill, heard a loud report distinctly while the walls of the Humboldt Mill were still standing and at the same time were knocked down. Immediately after they saw flames issuing from the basement windows of the Humboldt Mill and at the same instant, before they could regain their feet, they experienced a second shock and miraculously escaped being buried beneath the falling walls.

The enormous and sudden displacement of air which followed the explosion, and the tremendous force which was consequently exerted laterally, was shown in the condition of the round-house of the Chicago, Milwaukee, and St. Paul railroad, and the broken windows in all directions. The round-house was a wooden structure about forty or fifty feet from the Diamond Mill. The sills were drawn out toward that mill until the building burst, letting a part of the roof fall in and leaving the sides standing at a sharp angle. Ordinary windows, and those of strong plate-glass on Washington avenue, one-fourth of a mile distant, were projected into the street. Not only the glass but the sash went out bodily, particularly in the lower stories of the buildings. Persons on the river at the water's edge noticed a displacement of the water producing a wave estimated to be eighteen inches high, before they heard the report of the explosion.

Whole sheets of the corrugated iron with which the elevator was covered, measuring eight by two feet, but quite thin, were picked up on the east side of the river more than two miles distant, and pieces of six-inch flooring from two to ten feet long were carried to intermediate points.

An examination of the ruins of the several buildings showed that the walls of the Humboldt Mill lay upon those of the Diamond Mill, and those of the Diamond Mill upon those of the west end of the Washburn A Mill, showing that the buildings did not explode simultaneously but successively. The Washburn A Mill evidently exploded first from fire originating within it, and the high wind prevailing at the time carried the *flame* into the adjoining mills to the south, and away from the mills next the river. There was enough burning middlings and flour thrown through the broken windows of the latter mills to set them on fire, but they did not explode. Some significance may attach to the fact that the three mills that exploded were all running with more or less open French middlings purifiers, while the three that did not explode had been shut down for several days. There is no question but that the French purifiers project a great deal more dust into the atmosphere of the mills than those that are enclosed, but I have no doubt that in *any* flouring mill sufficient dust accumulates upon beams and machinery to produce an explosive atmosphere if from any cause this dust is scattered into the air and flame is communicated to the mixture while the dust is suspended.

There was less than a barrel each of lard oil, lubricating oil, and high-test kerosene in the Washburn A Mill at the time of the explosion.

There is absolutely no proof that any explosive material other than is produced in the manufacture of flour from wheat was in any one of the buildings destroyed, in the cars around them, or in the neighbourhood. The testimony of millwrights conclusively showed that fire produced by heated bearings is of such extremely rare occurrence in flouring mills as to practically exclude such a cause.* No suspicion of incendiarism has ever been expressed.

A slight fire, the effects of which were in no wise serious, occurred in the Washburn A Mill about three months before the explosion. It was discovered from the outside of the mill that smoke was issuing from a spout or conductor that discharged the air that was drawn through between the stones. The object for which the air is drawn through is to cool the stones and to carry off the vapour produced from the wheat by the rise of temperature due to friction. In this case the effects of *fire* were traced back from the outside of the building to one of the sets of stones on the north side of the mill used for grinding middlings. The effects of *flame*, however, did not extend beyond the blower which produced the exhaust. This led to the conclusion that the fire did not enter the dust-house, although the smoke must have passed through it. It is supposed that the fire was caused by friction between the stones, they having run dry from one of the causes that may produce dry stones.

In answer to enquiries made of several millers in the Minneapolis Mills, I found them uniformly of the opinion that the meal or flour as it left the stones had a temperature of about 100° F. or less. A number of careful experiments, made with an ordinary chemical thermometer, showed that the wheat enters the stones from the dryers at a temperature of fully 100° F., and that it leaves the stones at 120°—130° F. The temperature of the ground middlings as it left the stones averaged about ten degrees higher.

It was also the concurrent testimony of millers and mill owners that dry stones are of comparatively frequent occurrence, and that they are practically unavoidable. I am convinced that in the Washburn A Mill the frequency of danger from dry stones was considerably increased in consequence of the large number of stones in the mill, and especially from the fact that so few men were employed having the immediate oversight of the stones. Only two men were employed at the same time for the forty-two run of stone, a number inadequate for that supervision which so important a matter demands, as it is impossible from the large space occupied by so many stones, and the noise incident to their action, that even with the usual signals employed dry stones should be detected as soon as they become a source of danger.

Obstruction of the feed from any one of a number of accidental causes will produce dry stones. The danger

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* These gentlemen concurred in the statement that the spindle which carries the stone had been known to become *welded* into the socket in which it revolved, stopping the stone. When asked if the friction produced a welding heat, one replied, "No, nowhere near it." It must be an example of perfect metallic contact, producing cohesion.

arises from the friction of the stones heating the last portion of the grist that remains between the stones to a temperature sufficient to char it, or convert it into a substance resembling tinder, which would readily ignite from a spark produced by the stones striking together. Another source of danger arises from nails or gravel passing between the stones with the grist and increasing the friction, producing either a rise of temperature or a train of sparks; perhaps both.

I am aware that numerous instances of dry stones can be cited that have proved perfectly harmless. An instance is on record in which a run of stone ground each other all night with no other result than the complete removal of the grooves which gave the stones a cutting face. On the other hand, cases have occurred in which the grooves became filled with charred wheat of a dark brown colour, packed into them so solidly as to require a mill-pick for its removal. It requires no argument to show that this tinder thus formed would become ignited from a train of sparks that would inevitably follow contact of the stones as the grist became compacted or completely removed from between them. It was found by experiment* that masses of flour that had become heated and charred, ignited readily and smouldered, but were inflamed with considerable difficulty; but it should be borne in mind that a number of sets of these stones are connected with a common spout or conductor, through which a strong current of air is being continually drawn, and which is filled with a dense cloud of very fine particles of starch (chiefly) heated to a maximum temperature of 140° F. Experiment also proved that the proper mixture of flour dust and air would not burn explosively except when brought in contact with *flame*. White-hot wires and glowing charcoal only burned the particles in contact with them. But it was found that burning pellets of charred wheat and flour would ignite wood, which a strong draft of air readily fanned into a blaze. Under the conditions previously stated with a draft of air passing through the dry stones strong enough to convey the pellets of smouldering tinder into the common wooden conductor an explosion becomes possible.

It is urged that these conductors are damp from condensed moisture, and also that a large amount of moisture escapes from the wheat and is conveyed away by the current of air. This loss is, no doubt, correctly estimated at from five to six per cent. It is, however, chiefly during the first grinding of the raw wheat that this loss is experienced. The middlings is drier, is ground at a higher temperature and is ground finer, producing more dust. The higher temperature renders the material more inflammable, and at the same time ensures a more complete solution of the vapour in the current of air. Moreover, the first fire in the Washburn A Mill was traced directly to a set of stones which ground nothing but middlings, and all that is known concerning the origin of the fire that produced the explosion confirms the supposition that that fire originated in a set of stones on the opposite side of the mill, which was one of six sets, all of which were used exclusively for grinding middlings, discharging into a common spout or conductor which communicated directly with a dust-house in which the dust settled to the amount of several hundred pounds a day. An explosion in this conductor, communicating *flame* to the dust-house, would scarcely fail to cause the successive explosions of the dust-house and the different stories of the mill, the shock of the first explosion being sufficient to throw the dust of the mill into the air.

The opinion expressed by one of the witnesses at the inquest, "that stones are liable to run dry at any time by accident," and that "dry stones can hardly be avoided by any amount of foresight," appears to be generally entertained by millwrights, millers, and mill-owners. Let it be granted that all experience shows that ninety-nine per cent. of dry stones injures nothing but the stones themselves, the one per cent. of residue is burthened with fearful possibilities. If dry stones cannot be prevented in small mills, where one miller has charge of perhaps six run of stone, the danger is more than proportionally increased in a mill where one man has charge of twenty run, both with reference to prevention and detection. The problem, therefore, for the consideration of parties immediately interested is how to prevent or detect dry stones, particularly those used for grinding middlings. This practical problem appears to be fundamental, and one compared with which all others are without much importance. It is true that but few millers are without their experience of minor explosions or flashes resulting from careless use of lanterns or open lights. Indeed, I have been profoundly impressed with the generally innocent reputation of flouring mills when considered in the light of the immense number of accidents well known to millers and insurance companies; a number surprisingly large if confined to those occurring in the States of Minnesota and Wisconsin within a few years past. The remedy in such cases is so obvious that the most ordinary care and intelligence is sufficient.—*American Journal of Science.*

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UPON THE DETECTION AND ESTIMATION OF NITROUS ACIDS IN POTABLE WATERS, ACIDS, &c.

By ALBERT R. LEEDS.

II.—WITH POTASSIUM IODIDE.

THE well-known method of Trommsdorf is of a colorimetric character.* The potable water to be examined is treated with a solution of zinc iodide, starch, and sulphuric acid, which develop, in case nitrous acid is present, a blue colour. The amount of nitrous acid corresponding to this colour is found by striking in distilled water containing these reagents the same tint with a standard nitrous acid solution. Ordinarily, the unknown and known solutions are prepared at the same time and placed side by side, in order that they may be subjected, as nearly as may be, to the same conditions. It is essential, in fact, that they should be equally exposed to the action of the air, and should be acted upon by light of equal intensity and for an equal length of time. To point out the importance and necessity of these precautions is the object of the present paper. Our attention was drawn to them in the course of preceding studies, upon the rate of change of soluble iodides in the presence of free acids, and the results of those studies have been given at length (*Journ. Amer. Chem. Soc.*, vol. i., 1879).

Briefly to recapitulate, these results are as follows:— *In the dark*, access of air being freely permitted, the amounts of iodine set free, the amount of free acid present being the same in every case, increases with the increase in percentage of dissolved iodide. *In the light*, the iodide liberated, in the case of solutions of equal strength, increases with the amount of exposure to the light and the intensity of the illumination. When air is entirely excluded no decomposition occurs even at temperatures above the boiling-point, and when exposed for days to the direct light of the sun.

These conditions of change having been established, it became of interest to determine in what way the mimetric method of Trommsdorf could be replaced by an absolute mode of volumetric estimation.

As a preliminary determination, the limits of sensitiveness of the zinc-iodide starch solution were investigated, and the rapidity with which it would undergo change in presence of acid in diffused daylight. Nine comparison-

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* Experiments made by Prof. L. W. Peck before the coroner's jury.

* *Zeit. f. Analyt. Chemie*, viii., 358.

tubes were placed in the comparator-frame, and in each was introduced 100 c.c. water, 1 c.c. H_2SO_4 (free from nitrous acid) and 3 c.c. zinc-iodide starch solution. This last solution was prepared by adding to 20 grms. $ZnCl_2$ and 5 grms. starch, 2 grms. ZnI_2 and 1000 c.c. water. The reagents were prepared in the laboratory, and were perfectly pure. To the nine tubes were added 0·2, 0·4, 0·8, 1·00, 1·50, 2·00, 2·50, 3·00, and 5·00 c.c. of a standard solution of potassium nitrite, containing per 1 c.c. 0·01 m.grm. N_2O_3. In other words, the first tube contained 2 parts; the ninth, 50 parts of N_2O_3 in 100 million. This last changed immediately, the others as follows:—

With	3	c.c.	N_2O_3 solution,	after	10	minutes.
,,	2·5	,,	,,	,,	15	,,
,,	2·0	,,	,,	,,	18	,,
,,	1·5	,,	,,	,,	50	,,
,,	1·0 and 0·8	,,	,,	,,	1 hour.	
,,	0·4 and 0·2	,,	,,	,,	1 ,, 50 mins.	

A tenth tube, containing 100 c.c. H_2O, 1 c.c. H_2SO_4, and 3 c.c. ZnI_2, and *no nitrite*, at the end of two hours had acquired a faint blue colour; in depth, however, inferior to that given by the 0·002 m.grm. N_2O_3 in the first tube. It will be seen from this table that the reaction cannot be applied to waters containing as much as 0·05 m.grm. N_2O_3 in 100 c.c. Perhaps 0·04 m.grm. in 100 c.c. is the superior limit, waters containing larger amounts than this requiring suitable dilution. And, moreover, since the very dilute solutions did not change at the expiration of intervals increasing progressively with the order of dilution, the determinations in these cases are affected with a corresponding degree of uncertainty. This is still more strikingly the case when ordinary potable waters, which are seldom colourless and contain various substances in solution, are used. For example, we have known the water of the Passaic River, which contained, according to a determination on one sample, by means of meta-diamido-benzol, 1·2 pts. N_2O_3 in 10 millions, to remain unchanged, on the addition of zinc-iodide starch and sulphuric acid, at the expiration of eight hours. After the same interval, distilled water, containing the same reagents, but no nitrite, had acquired a well-defined blue tint.

Apparatus for Absolute Volumetric Determination.

The preceding considerations, having demonstrated the importance of comparing the results obtained by the colorimetric method with those which would be gotten by some mode of absolute volumetric determination, an apparatus for effecting the latter object was constructed as follows:—Two comparison-tubes were fitted up in a manner similar to wash-bottles, except that the first comparison-tube was made to slip up and down upon its exit-tube. In this way its exit-tube might be forced down into the bottom of the first vessel when desired. The reagents were placed in the first comparison-tube; 100 c.c. of the liquid to be tested in the second. After a current of carbonic acid, washed by passage through a potassium iodide solution, had passed through both vessels for an hour, the exit-tube of the first vessel was pushed down, as above described, and the reagents forced over into the liquid under examination. In this way, the air dissolved in the reagents was swept out of them before they were allowed to come into contact with the unknown solution. A slow current of carbonic acid was maintained for two hours, at the end of which time the liquids were titrated. The reason for allowing so long an interval to elape before titration was that it had been found previously to be necessary, in order to permit so small a quantity of N_2O_3 as 2 parts in 100 millions to decompose their entire equivalent of potassium iodide. So effectually does the exclusion of air prevent the liberation of iodide under the influence of light alone, that no disturbing influence is exerted upon the results, even when the comparison-tubes are exposed to the direct rays of the sun for two hours or longer.

Example:—100 c.c. containing 0·05 m.grm. N_2O_3 were introduced into the second comparison-tube, and 6 c.c. zinc-iodide starch and 1 c.c. H_2SO_4 in the first. After complete displacement of the air dissolved in reagents and solution, the reagents were forced over, and the current of carbonic acid gas continued. On titration with sodium hyposulphite, at the end of two hours, the amount required was 0·032 c.c.=0·160 m.grm. I. The theoretical amount was 0·0334 c.c.=0·167 m.grm. I=0·05 m.grm. N_2O_3.

Effect of Colouring Matters.

These experiments give the key to an explanation of the effect of colouring matters and organic impurities upon the rate of change of acid solutions of the soluble iodides. They suggest, likewise, a method of eliminating the perturbations so arising from titrations in which iodides are employed.

Colouring matters, &c., disturb the identity of conditions under which the colorimetric titration is made. Such an identity is more especially important in a determination like this, inasmuch as the liquids are undergoing a slow spontaneous alteration by contact with light and air. All colouring matters absorb more or less of the actinism of solar and other light, and, consequently, the amounts of iodine set free will differ correspondingly in solutions containing them. This absorbing action is especially great in the case of yellow solutions which, like caramel, cut off the more refrangible rays of the spectrum. If in addition to being coloured, these foreign bodies are decomposable and capable of combining with any of the oxygen of the dissolved air, their disturbing influence is two-fold. In the first place, they alter the rate at which acid solutions of soluble iodides decompose under the action of diffused or direct light, and secondly, they remove a portion of the oxygen which is essential to the progress of this decomposition. The conditions governing the reaction are summed up in the general equation,—

$$4MI + 4HA + O_2 = 4MA + 2H_2O + 2I_2,$$

where M stands for any monovalent basic radical, and A a monobasic acid radical. (See "Influence of Light upon the Decomposition of Iodides," *Journal Amer. Chem. Soc.*, vol. i., part 3, by the author.)

Illustration: These suppositions were confirmed by the following experiment: Four comparison tubes were prepared, each containing 1 c.c. KI sol. (20 p. c.) + 1 c.c. H_2SO_4 + 100 c.c. H_2O + 0·05 mgrm. N_2O_3. Enough caramel solution was added to each to communicate a strong colour. All four were exposed to sunlight for one hour, but through two of them a current of washed carbonic acid was passed, while the remaining two solutions were in direct contact with air. The results were as follows:

Caramel Solutions.

In Air.

I. Required 0·95 c.c. $Na_2S_2O_3$ = 1·4 m.grm. N_2O_3.
II. ,, 0·90 ,, ,, = 1·35 ,, ,,

In Carbonic Acid.

III. Required 0·05 c.c. $Na_2S_2O_3$ = 0·099 m.grm. N_2O_3.
IV. ,, 0·05 ,, ,, = 0·099 ,, ,,

It will be seen, that even where carbonic acid was employed, the amounts of N_2O_3 which were found are twice those of the A_2O_3 used. This excess was due to using reagents, out of which the dissolved air had not previously been driven by a current of carbonic acid. When this was done, by means of the apparatus before described, the results agreed with the theoretical. In case of the *solutions exposed to air*, *the discrepancy is enormous*, being nearly thirty times too great. Similar results were obtained in diffused light, but a greater length of time was required to produce them.

Conclusions.—The following conclusions are to be drawn from the preceding experiments:

I. *When the solutions to be titrated are colourless, and contain no compounds, organic or inorganic, which would* *affect the percentage of dissolved oxygen*, the determination may be made by the colorimetric method.

II. When the solutions are coloured, or contain organic or other bodies capable of absorbing oxygen, the *air must be entirely removed from the liquids in order to obtain good results, and an absolute volumetric determination is essential.*

With regard to the first point, it is to be remembered that, in any case, the colorimetric method less and less approximates to accuracy as we approach the lower limit of the reaction. This is due to the difficulty of securing equivalent amounts of change in excessively dilute solutions, when these solutions contain iodides in presence of free acid, and are not at the same time absolutely identical in tint and constitution. And, with reference to the second point, inasmuch as the colouring matter cannot always be removed from potable waters, by throwing them down through the formation of an insoluble precipitate, it is of utility to possess a method of determining nitrites in presence of colouring matters, and sometimes of certain classes of organic impurities.

Examination of Hydrochloric Acid for Chlorine, and of Nitric and Sulphuric Acids for Nitrous Acid.

After the preceding statements, it will be easily seen that the ordinary rule given in works on qualitative analysis, for the examination of sulphuric acid (*i.e.*, dilution with 20 pts. water and addition of potassium iodide and starch results), gives erroneous results when employed to detect minute quantities of nitrous acid, and the solution is allowed to stand for some time. But if the trial is made in an atmosphere of carbonic acid, care being used to expel previously all traces of air in reagents and in the dilute acid solution, the test and estimation of percentage may be satisfactorily performed. The same remark applies to the examination of hydrochloric acid for chlorine, by means of a soluble iodide. In the case of nitric acid, however, it is well not to expose the acid when under examination too long to the action of strong light, owing to the liberation of oxygen from the nitric acid itself under these circumstances. The ease and certainty with which the Griess reaction for nitrous action is performed should cause it to replace the former methods in most cases. So delicate is it, that the acids sold as chemically pure usually give a decided colour when the meta-diamidobenzol is added to them, and the general introduction of this reagent into use will probably raise the standard of so-called purity, at least in this respect.

Upon the Degree of Concentration at which Soluble Iodides will cease to remain unchanged in presence of Free Acid, even when out of Contact with Air.

The method pursued in examining this question, was to employ solutions of iodides and acid of gradually increasing concentration, until a point was attained at which decomposition ensued, even when all traces of air were rigorously excluded. The reagents were placed in the first, the iodides in the second comparison-tube, of the apparatus before described, and when all the air had been expelled from both, by the long-continued passage of carbonic acid, the reagents were forced over into contact with the iodides. In the first experiment, 1 c.c. KI (10 p. c.) + 5 c.c. H_2O and 1 c.c. H_2SO_4 (chemically equivalent to the 1 c.c. KI) + 5 c.c. H_2O, were employed. After expulsion of air, the solutions stood one hour in diffused light, and half-hour in sunlight, a slow current of carbonic acid flowing. On disconnecting and adding starch, no colouration took place.

In the second experiment similar solutions were used, but instead of being diluted to the $\frac{1}{100}$th, they were diluted only to the $\frac{1}{20}$th. They were exposed to diffused and direct sunlight for the same intervals. Before addition of starch, no change of colour was perceptible, but afterwards, a *brownish-red*. This compound was entirely unlike in appearance to that formed by the union of free iodine with starch, under ordinary circumstances.

III. The reagent contained 5 c.c. KI (10 p.c.) + $2\frac{1}{2}$ c.c. H_2O; in other words, they were now diluted only to one-tenth. After exposure for one-and-half hours to *direct sunlight*, they were brought into contact, when the same *brownish-red* precipitate was formed.

IV. No water was employed, but in its place $2\frac{1}{2}$ c.c. starch-water, with the same amounts of sulphuric acid and potassium iodide. They were exposed, after expulsion of air, to diffused light for one hour, and then to sunlight for one-and-half hours. No change occurred in either comparison-tube until their contents were mixed, when the *brownish-red* precipitate formed immediately, On the addition of sodium-hyposulphite, the colour disappeared, showing that it probably contained either iodine or hydriodic acid. On collecting and washing the precipitate on a filter, it turned blue, and presented the ordinary appearance of iodide of starch.

V. A final experiment was made by dissolving 10 grms. KI in 30 c.c. starch-water. 20 c.c. of this solution were placed in the first comparison-tube, 10 c.c. concentrated H_2SO_4 in the second, and both treated with carbonic acid. The tubes were exposed to direct sunlight. In a few minutes the first comparison-tube exhibited a brown colouration, and after several hours a carmine-red precipitate was formed. After being allowed to stand over night, the red precipitate was still present, but another also, of a darker hue, lay above. On allowing the carbonic acid to flow through both precipitates for six hours, in the sun-light, they disappeared, and the original *brown colouration only* was visible. During this part of the experiment, the iodide and starch, it will be noted, were not mixed with the acid. Finally, they were driven over, when immediate decomposition ensued, and a large amount of iodide was set free.

Conclusions.—1st. In the absence of air and presence of carbonic acid, decomposition of an acid solution of potassium iodide occurs, when the concentration has attained to some point between one-third and one-tenth the weight of the water employed. 2nd. During the course of these experiments, a compound of starch has been formed which, from its deportment with reagents, and more especially from its turning blue on absorption of oxygen, may probably be regarded as a *hydriodide of starch.* An attempt would have been made to study it further had it not been for the difficulty of satisfactorily isolating a body which changed so readily on exposure to air into ordinary starch iodide.—*Journal of the American Chemical Society.*

CONTRIBUTIONS TO THE ESTABLISHMENT OF A RATIONAL SYSTEM OF EXAMINING WATER AS REGARDS ITS INFLUENCE UPON THE HEALTH OF MEN AND ANIMALS.

By Dr. F. HOLDEFLEISS.

(ABSTRACT.)

THE author, after a careful survey of the methods proposed and the results obtained, concludes that it is rarely practicable to determine the character of a water satisfactorily by chemical analysis alone. Microscopic examination, though too much neglected, promises more satisfactory results in as far as the organisms observed have been found to bear certain relations to the sanitary value of the water. The following points may be considered established:—

Only natural, freshly-drawn water, and the deposit taken from the bottom or sides of the well, tank, &c., should be submitted to examination.

Not the number of the organisms present, but their nature, must be regarded as decisive of the state of the water.

For the object in view the organisms present in water may be divided into three classes:—

(1.) Such as can live only in sound good water, which in any appreciable extent shows no suspicious decomposition of organic matter. Such organisms perish as soon as deleterious products of decomposition are met with in the water. Among this class are included the diatoms or Bacillaria, which, however, indicate a wholesome condition of the water only when found living. If we discover in a water merely the silicious shells of diatoms without their coloured contents, this is *per se* a certain sign of the suspicious character of the water. It is not necessary to determine the species, but merely to ascertain whether the shells contain protoplasm of normal texture and colour. *Spirogyra*, *Cladophora*, and other green thread-like Algæ live only in good waters. They die off, their green chlorophyll shrinks up, and disappears when injurious decomposition products are introduced. They leave, however, no silicious shells behind, but perish altogether. The Desmidiæ behave in a similar manner. All these organisms, by means of their constituent chlorophyll, decompose the carbonic acid dissolved in the water for their nourishment.

(2.) Organisms free from chlorophyll, nourished solely from putrescent organic matter, and directly promoting the decomposition of organic matter, nitrogenous or non-nitrogenous. Such organisms can live only in waters which evince processes of putrefaction and an unwholesome, dangerous character. The presence of this group pre-supposes decomposing matter. Among these must be included *Beggiatoa alba*, a colourless alga, whose presence appears to be closely connected with the formation of hydrogen sulphide. Beggiatoa is found in bad well-waters, whilst the diatoms and other algæ cannot live in covered wells, as they require light. Very similar is *Leptomitus lacteus*, which, however, gives off no sulphuretted hydrogen. We must also include *Crenothrix polyspora*, *Selenosporium*, and *Zooglœa*. Here likewise must be classed the Schizomycetes, the bacteria, monads, vibriones, &c., minute vibratory corpuscules which are developed in especial abundance where nitrogenous matter is plentiful. Hence the danger to be apprehended may be estimated by their abundance. The microscopic indications may here be usefully verified and supplemented by the highly sensitive tests for ammonia and nitrous acid.

(3.) In an intermediate group we place organisms which can live either in good or bad waters, such as the Oscillariæ, *Euglena viridis*, and the majority of the larger *Infusoria*.

We must distinguish between the water from (covered) wells and open waters, whether flowing or standing, and again between such as, up to the taking of the sample, have been entirely secluded from the light, and such as have been at least temporarily exposed to the sun, such as spring-waters.

Well-water is to be regarded as good when free from all organism, from ammonia, nitrous acid, and hydrogen sulphide.

Open waters, flowing or standing, are good when they contain living green algæ and diatoms with the contents of the shells normally coloured, but no colourless algæ (*Beggiatoa*, *Leptomitus*, &c.), and no, or but few, *Schizomycetes*.

Drinking-water for human use, in addition to freedom from all organisms, from ammonia, nitrous acid, and sulphuretted hydrogen, should not exceed 18—20° of hardness. If river-water is so purified by filtration that it possesses these properties, and that suspicious organisms do not reappear on standing, it may be used without scruple.

Open waters containing green algæ and living diatoms and free from ammonia and nitrous acid may be consumed with safety.

For cattle traces of ammonia and nitrous acid in pond- and river-water may be tolerated if green algæ and living diatoms are present.

Water for fish-ponds should be free from sulphuretted hydrogen and should be rejected if *Beggiatoa alba* is present in a state of normal vitality. *Leptomitus lacteus* is probably dangerous.

The mere vicinity of waters containing *Beggiatoa* and the *Schizomycetes* is dangerous, as they may infect the atmosphere and communicate germs of a dangerous nature to the ground-water and the wells.—*Biedermann's Central-Blatt.*

NOTICES OF BOOKS.

Proceedings of the Twenty-sixth Meeting of the American Pharmaceutical Association, held at Atalanta, Georgia, November, 1878. Philadelphia: Sharman and Co., 1879.

This is the first time that the American Pharmaceutical Association has held its meetings in the Southern States, where pharmacy has hitherto been generally neglected. The present volume, containing nearly a thousand pages, is marked by the same thoroughly practical character that we have had occasion to praise in preceding notices. There does not seem to be a single paper or extract which does not contain numerous items of information calculated to help the working pharmacist in his everyday labours. During the past year, the Committee appointed to revise the U.S. Pharmacopœia appear to have done good work. The following recommendations have been made with regard to the new edition, viz., that the language used should be English, and that the present division into Materia Medica and Preparations should be abolished, and an alphabetical arrangement adopted. A list of the proposed elisions and additions is also published, and the comments of the medical and pharmaceutical professions are invited. Temperatures will be expressed both in F. and C., and double formulæ will be given in the case of chemical preparations of definite composition. Measures of capacity are to be entirely abolished and weights substituted. Other important additions are to be made in the form of tables. One of the most important reports was that read by Mr. C. L. Diehl, on "Fluid Extracts by Percolation," which is quite exhaustive in its character, a remark which applies equally well to that by Dr. Squibb, on "Fluid Extracts by Re-percolation." The Annual Report on the Progress of Pharmacy during the year ending June 30, 1878, extends over 644 pages, being more than double the length of that of last year. The next meeting will be held at Indianapolis.

CORRESPONDENCE.

ASHES OF WHEAT BRAN.

To the Editor of the Chemical News.

Sir,—In your issue of June 20 (Chemical News, vol. xxxix., p. 276), just come to hand, I notice a criticism by J. Carter Bell, of the article "On the Ashes of Wheat Bran" which appeared in your number for June 6th, of which I am the author.

I beg to call Mr. Bell's attention to the fact that he has been analysing one thing while Miss Brown analysed another. By comparing notes, he would have informed himself that he has been examining "bran from white English wheat," while Miss Brown examined an ash residue of Minnesota wheat bran from under a boiler. No phosphate of alumina was given among the results of the analysis, because a careful examination of the substance analysed failed to reveal the presence of an appreciable amount of alumina.

The amount of sulphuric oxide (SO_3) should read 1·151 per cent., and the total 99·259 per cent.

While thanking Mr. Bell for his courtesy, I venture to suggest that in future, before he attempts the *rôle* of critic he ascertain what play is being played.—I am, &c.,

S. F. PECKHAM.

July 16, 1879.

EXPLOSIONS IN FLOUR MILLS.

To the Editor of the Chemical News.

SIR.—I have noticed in late numbers of CHEMICAL NEWS several communications on Flour Mill Explosions. In these reference is made to a letter of J. Lawrence Smith's to M. Dumas in respect to this matter. This letter I have not yet seen, but judging from the fact that Dr. Smith was supplied by myself with all of the information to be obtained here on the subject, including descriptions of experiments made before the coroner's jury by Professor L. W. Peck, a summary of the testimony given, and plans of the buildings destroyed, his opinions were based upon the facts.

In the *American Journal of Science and Arts* for October, 1878, will be found an article in which I made a record of all of the facts that I had learned likely to prove of scientific interest, to which I beg the attention of any one interested. Professor Peck and myself were requested to attend the sittings of the coroner's jury to act as experts and examine witnesses. We heard every word of the testimony, and very soon agreed in the conclusion that the mills exploded from ignition of a mixture of wheat dust and air. In fact, we came to that conclusion before we heard the testimony, and within twenty-four hours of the time the mills exploded. The testimony only established these convictions, and the experimental and theoretical proof placed them beyond doubt or question. In the controversy that followed the publication of these opinions, we for the first time saw a statement of the views held by Professor McAdam, and extracts from his paper. It appears to me that no other conclusion is possible when the subject is discussed on scientific principles, and that all of the talk about "distilling flour," "hydrogen," and "mystery," is superlative nonsense.

I enclose by the same mail a copy of the reports made by Professor Peck and myself before the coroner's jury, also the paper above referred to from the *American Journal of Science and Arts* and a paper from the *Popular Science Monthly*, in which the experiments are described by which the explosive force generated by burning flour dust is shown. It is, of course, too much to ask you to re-publish these; but on looking them over you may conclude to make such extracts as will assist in disseminating correct information on a subject of so much public importance. Both English and American millers are slow to believe that a flour sack can contain so much potential energy, yet we have here among those who produce the weekly grist of 35,000 lbs., men of long experience, who wonder that any intelligent person should question such a statement.—I am, &c.,

S. F. PECKHAM.

July 16, 1879.

PECULIAR SPECTRA OF LIGHTNING.

To the Editor of the Chemical News.

SIR,—In your issue of August, 25th, 1871 (CHEMICAL NEWS, vol. xxxiv., p. 96), I endeavoured to describe some peculiar spectra of lightning observed in Cornwall, and which were kaleidoscopic in their complexity; the dominant spectra, however, being suggestive of copper. Subsequent enquiry and reflection made it probable that the spectra were really those of copper and of other metals; for in the general direction in which I examined the lightning was a smelting-house, from the tall chimney of which issued the fumes arising from the processes connected with the extraction of silver from lead and copper ores; and on the evening of my observation a remarkably brilliant display of varied colour had been observed accompanying the play of the lightning upon the metallic and metalliferous heaps lying around the yard of the works. Nor should it be forgotten that the district itself is a metalliferous one.

Numerous examinations since then of the spectra of lightning in two other counties—Sussex and Hants—have revealed to me no similar spectra in the atmosphere.

The intense fusing power of atmospheric electric discharges upon the mineral substances of the earth, as instanced in the "fulgurites" or silicious tubes penetrating the sands of South America and other places, suggested to me that another but transient effect of the discharge would be the diffusion along its path of metallic substances, strikingly contrasted in scale with metallic diffusion along the voltaic arc of the laboratory. Gold, from its occurrence in the metallic state, ought thus readily to reveal its situation, whether in regions easily accessible or not. It seems obvious that the instrumental observation of the spectroscopic character, and the direction of the lightning with the interval of flash and report, would be sufficient to determine the character and situation of exposed metalliferous deposits in unexplored districts. Nowhere would such observations be better repaid, perhaps, than in Natal; for as recorded by Dr. Mann, nowhere in the world can the colorific displays of lightning be grander than in Natal. Indeed, my somewhat old ideas on the subject have been revived by our present interest in that quarter.—I am, &c.,

JOSEPH GIBBONS.

Uphurstbourne, Hants, July 31, 1879.

DETERMINATION OF SILICON IN IRON AND STEEL.

To the Editor of the Chemical News.

SIR,—The experiments of Mr. Thomas M. Brown, described in the CHEMICAL NEWS for July 25th (page 40), are interesting and of practical value; but there is one assumption which is not warranted by the facts.

Mr. Brown, and many other chemists, assume that when silicious iron is dissolved in hydrochloric or sulphuric acid, the white residue which separates consists of silica, and Mr. Brown remarks that the silica resulting from the action of either of the above acids is "light and flaky," while nitric acid gives a compact and granular product.

It has been shown by several chemists, and attention was drawn to the fact by me in a letter which appeared in the CHEMICAL NEWS for February 20, 1874, that the light flocculent residue obtained by the solution of silicious iron in hydrochloric or sulphuric acid consists chiefly of a lower oxide of silicon (called by Wöhler "Leukon"), the formula of which has been differently stated as $2SiO,H_2O$, and SiO,H_2O. The latter formula corresponds to that of a silico-formic acid, $H.SiO.OH$. At any rate, the fact that the body in question is a less highly oxidised compound of silicon than SiO_2 is proved by the following reactions.—

1. The residue dissolves in alkalies with evolution of hydrogen and formation of an alkaline silicate.
2. The washed residue is not wholly insoluble in water, and the aqueous solution is a powerful reducing agent.

Evidently, then, the proportion of silicon which passes into solution is dependent on the volume of liquid present and the quantity of water used for washing. No doubt the concentration of the acid and the temperature of the operation are also important factors, and, in short, the number of the conditions affecting the result is so large that the proportion of silicon which passes into solution is little other than accidental. As the filtrate contains the lower oxide and not silica, it does not at all follow that simple evaporation to dryness is sufficient to render it insoluble. However, during evaporation more or less oxidation occurs, and if the solution contain any ferric chloride there can be little doubt that the whole of the dissolved silicon is recovered as insoluble silica.

I may add that I have several times had reason to suspect the formation of traces of silicide of hydrogen during the solution of highly silicious spiegeleisen in hydrochloric acid, but have never succeeded in verifying my suspicions.

I note that Mr. Brown finds that the "silica" obtained by the solution of the iron in sulphuric acid will seldom burn white. This is in accordance with the known properties of the lower oxide of silicon, which on ignition gives off silicide of hydrogen, and this is decomposed with deposition of more or less silicon.

I conclusion, I may say that five years' additional experience has resulted in still stronger confidence in the method of estimating silicon described by me in the Chemical News, vol. xxix, p. 91.—I am, &c.,

Alfred H. Allen.

Sheffield, August 6th, 1879.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 26, June 30, 1879.

Chemical Constitution of Alkaline Amalgams.—M. Berthelot.—The author has prepared a series of alkaline amalgams, both liquid and solid, treated them with dilute hydrochloric acid and measured the heat evolved. At the same time the analysis of the resulting liquid showed the proportion of alkaline metal contained in each, which is always less than that employed in the preparation. The heat of oxidation of amalgams rich in potassium exceeds that of amalgams rich in sodium. It is not the same with the amalgams richest in mercury, the heat of formation of such potassium amalgams surpassing that of the corresponding sodium amalgams by a quantity which may reach +8·6 cals. for $Hg_{12}K$ as compared with $Hg_{12}Na$. The oxidation heat of potassium surpasses that of sodium in an inverse direction and only by +4·7 cals. Hence the oxidation heat of potassium amalgam may be reduced to +48 cals., that of sodium in analogous conditions being +56 cals. This accounts for the displacement of potassium in a solution of potassa by sodium amalgam.

Peculiarity of an Experiment by Gay-Lussac and Thénard.—H. Debray.—These chemists in their experiments on the preparation of alkaline metals passed the hydrates of potassa or of soda in vapour over an excess of iron contained in a gun-barrel heated to the highest possible temperature. Hydrogen and vapours of potassium and sodium escape from the apparatus, and the corresponding oxygen remains fixed upon a part of the iron, but chiefly the part outside the furnace and relatively the least hot. The iron is in great excess in proportion to the quantity of oxygen to be fixed; hence, whatever may be the internal reactions produced at elevated temperatures it is fixed upon the interior parts.

Spectral Examination of Ytterbia.—M. Lecoq de Boisbaudran.—The author has submitted the aqueous solution of the chloride to the induction spark, and has thus obtained a fine spectrum, formed chiefly of bands grouped between the solar rays D and E. These bands are almost all shaded from the left to the right. The author thinks the existence of a specific emission spectrum for this new element the more important as its chemical reactions are not well characterised.

The Law of Stokes, in Reply to M. E. Becquerel.—S. Lamansky.—The author describes experiments to show that the difference between the phenomena of phosphorescence and of fluorescence is not confined to a difference in the duration of the luminous emission after the previous influence of the exciting rays.

Dissociation of Ammonium Hydrosulphate.—R. Engel and A. Moitessier.—A reply to the paper of M. H. Sainte-Claire Deville, of June 9.

Action of Phthalic Anhydride upon Naphthalin in Presence of Ammonium Chloride.—E. Ador and J. M. Crafts.—By this reaction the authors have obtained naphthoyl-orthobenzoic acid.

Biedermann's Central-blatt. July, 1879.

Ammoniacal Salts in the Seas of the Present and of Former Times.—L. Dieulafait.—The presence of ammonia in sea-water is general. It varies in quantity from 0·2 to 0·36 m.grm. The deposits from concentrated sea-water are strongly ammoniacal, that of the Pool of Lavalduc containing 250 times as much ammonia as the water of the Seine during its passage through Paris. Ammonia is present to a notable extent in gypsum, which must be regarded as a sedimentary formation from former seas.

Distribution of Ammonia.—Dr. Angus Smith.—From the Chemical News.

Contributions to the Establishment of a Rational System of Examining Water as regards its Influence upon the Health of Men and Animals.—Dr. F. Holdefleiss.—See page 63.

Influence of a Stratum of Vegetation and of Shade upon the Physical Properties and the Fertility of the Soil.—Prof. E. Woolny.—This paper does not admit of useful abstraction.

Absorptive Power of the Constituents of the Soil for Gases.—G. Ammon.—The condensing power of the ingredients examined may be arranged thus for watery vapour and ammonia:—Ferric oxide, humus, gypsum, kaolin, carbonate of lime. The action is greatest between the temperatures 0° and +10°, and decreases progressively both above and below these points. Hydrated ferric oxide converts the larger portion of the absorbed ammonia into nitric acid.

Justus Liebig's Annalen der Chemie, Band 197, Heft 3.

Amidines and Thiamides of Monobasic Organic Acids.—A. Bernthsen.—The author describes here the ethers of the thiamidic acids.

The Composition of Cinchonin.—Zd. H. Skraup.—The author's analytical results agree with the formula $C_{19}H_{22}N_2O$, better than with that generally accepted, $C_{20}H_{24}N_2O$. He also examines a number of its salts.

Oxidation Products of Cinchonin.—Zd. H. Skraup. The author examines the production of cinchotenin by the action of potassic permanganate upon cinchonin. A volatile acid was obtained which proved to be pure formic acid.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 5, 1879.

On Antichlor.—G. Lunge.—The author shows that a molecule of hyposulphite does not suffice for an atom of chlorine. Ammonia, which was proposed by Kolb as an antichlor, acts very imperfectly in dilute solutions and at ordinary temperatures, and the pungent odour produced by the reaction of ammonia or ammoniacal salts with the hypochlorites renders its practical application as an antichlor inadmissible.

Organic Ferrocyanides.—O. Bernheimer.—An account of the ferricyanides of tetra-methyl-ammonium and tetra-ethyl-ammonium.

On Berberin.—H. Weidel.—On treating berberin with nitric acid the author obtains no oxalic acid, but a finely-crystalline body, which he names berberonic acid, the preparation, properties, &c., of which are described at length.

Action of Melting Caustic Soda upon Phenol and Synthesis of Phloro-glucin.—L. Barth and J. Schreder.—The principal products of the reaction are pyrocatechin, resorcin, and phloroglucin.

On Cinchonin.—M. Fileti.—A preliminary communication. The author has obtained novel compounds on saturating a dilute hydrochloric solution of cinchonin with chlorine and bromine respectively.

Conquinin Sulphate.—O. Hesse.—A solution of conquinin sulphate in chloroform after standing for some months displays a green fluorescence almost as strong as Schær's solution of quinidin sulphate in chloroform.

Remarks on the Treatise of MM. Weselsky and Benedikt, "On certain Azo Compounds" (xii., 226).—P. Griess.—The author claims priority as regards the discovery of azo-benzol-naphthyl-amin. He considers that the practical application of such compounds as dyes is hindered by their sparing solubility in water, though their sulphacids may be applicable as orange dyes. If a liquid containing traces of nitrous acid is acidulated with pure sulphuric acid, then mixed with some solution of sulphanilic acid, and in about ten minutes afterwards with a few drops of a solution of naphthylamin sulphate, previously decolourised with animal charcoal, a red colouration shortly appears. In this manner nitrous acid can be detected in human saliva. In urine, contrary to the assertion of Schœnbein, it does not appear to be present.

On Isocymol.—O. Jacobsen.—The author describes a number of derivatives of this compound.

Oxyparaxylylic Acid.—O. Jacobsen.—An account of certain salts of this acid.

Purification of Mercury.—L. Meyer.—The author applies a dilute solution of ferric chloride in an apparatus which he here figures.

The Relation between the Melting-points of the Elements and their Coefficients of Expansion by Heat.—T. Carnelley.—A table which the author has compiled shows that with five exceptions the coefficient of expansion increases as the melting-point sinks. The five exceptions are arsenic, antimony, bismuth, tellurium, and tin; the three former of which belong to the same elementary group, and even these among themselves display a similar relation between their melting-points and coefficients of expansion. Why these five bodies form an exception does not yet appear. It must, however, be noted that they are all found on the ascending side of Meyer's Curve of the Elements (see his "Modern Theories of Chemistry"), whilst three of them, tin, antimony, and tellurium, follow immediately upon each other in the above curve. Arsenic, antimony, bismuth, and tellurium are all very brittle and belong to the same crystalline system, and bismuth and antimony are the only two known pure elementary bodies which expand on congealing. Tin, in some of its compounds, displays an abnormal melting-point as will be shown in a future memoir. Both the melting-points and the coefficients of expansion may be periodic functions of the atomic weight.

Presence of Meta-nitro-toluol in Commercial Nitro-toluol.—P. Monnet, F. Reverdin, and E. Nölting.—The authors have detected meta-toluydin by examining the acetyl derivatives of a commercial toluydin, free from aniline.

Part Played by Meta-toluydin in the Formation of Magenta.—P. Monnet, F. Reverdin, and E. Nölting.—The presence of meta-toluydin is in every mixture injurious to the purity of tone of the dye produced.

Quantitative Determination of Zinc.—F. Beilstein and L. Jawein.—The solution of the zinc, nitric or sulphuric, is mixed with soda till a precipitate is formed, and then with potassium cyanide till a clear solution remains. Platinum electrodes, conveying the current of four Bunsen's elements, are plunged into the liquid, which is kept cool if needful by plunging the beaker in a vessel of water. When all the zinc appears to be precipitated the electrodes are lifted out of the liquid, and the zinc is washed, first with water, then with alcohol, lastly with ether, and dried in an exsiccator. After weighing it is dissolved in hydrochloric or nitric acid, and the electrode, cleansed and weighed, is re-introduced into the liquid to ascertain whether the zinc has been completely precipitated.

Treatment of Bunsen Elements.—F. Beilstein and L. Jawein.—To preserve connecting wires, binding screws, &c., from rusting, the authors recommend that when cleaned they should be anointed with oleo-naphtha, a lubricant obtained from Caucasian petroleum.

On Nitrochinolin.—W. Kœnigs.—An examination of nitrochinolin, amidochinolin, and amidolepidin.

Modification of Simpson's Method of Determining Nitrogen.—W. Hankó.—This paper requires the accompanying engraving.

Synthesis of Chinolin from Allyl-anilin.—W. Kœnigs.—Allyl-anilin is passed over lead oxide at low redness, when chinolin is found among the products.

Production of Nickel and Cobalt in a State capable of being Rolled.—T. Fleitmann.—The author conceived the idea that the brittleness of these metals was due to absorption of carbonic oxide, and succeeded in removing it by the addition of small quantities of magnesium, obtaining both metals in a perfectly malleable and ductile condition. The magnesium is introduced through a hole in the lid of the crucible after the oxygen has been removed by the addition of fragments of charcoal. Otherwise explosions may ensue.

Action of Phosphorus Penta-chloride upon Isatin and Allied Bodies.—A. Baeyer.—The author considers that the best method of obtaining indigotin from isatin chloride is to treat the latter with a solution of hydriodic acid in glacial acetic acid.

Amido-nitro-sulphide of Iron.—W. Demel.—This somewhat complex body is obtained by the reaction of ammonium sulphide and potassium nitrite with the solution of a ferrous salt.

Novel Method of Forming Ketons.—G. v. Bechi.—Freund discovered a general method for the formation of ketons by the action of acid chlorides upon zinc-alkyles. The author finds that iodalkyles in presence of metallic sodium occasion the same reaction.

Proportion of Water in Calcium Glycolate.—C. Böttinger.—This salt crystallises with variable proportions of water according to temperature, &c.

Contribution to a Knowledge of the Ureids: Synthesis of Dimethyl-barbituric Acid.—E. Mulder.—Not susceptible of useful abstraction.

Oxidation of Ortho-toluol-sulphamids.—O. Fahlberg and Ira Remsen.—Not suitable for abstraction.

Schizomycetous Fermentation.—A. Fitz.—The principal fact here established is the non-existence of the so-called butyro-acetic acid.

Azo, Azoxy, and Hydrazo Compounds.—H. Schmidt and G. Schultz.—With the removal of oxygen from the nitro compounds the melting-point rises up to the azo compounds; the hydrazo compounds melt at a lower temperature than the azo and even the azoxy compounds (except hydrazo-benzol); and the amido derivatives melt lower than the corresponding nitro compounds.

On Diphenyl Bases.—H. Schmidt and G. Schultz.

On Diphenoles.—H. Schmidt and G. Schultz.—These two memoirs do not admit of useful abstraction.

No. 6, 1879.

Oxidation of Resorcin to Phloroglucin.—L. Barth and J. Schreder.—The operation is effected by melting resorcin in a silver capsule with a considerable excess of caustic soda. Shortly after the development of gases has decreased the source of heat is removed. the mass when cold is dissolved in dilute sulphuric acid, the liquid filtered, and the filtrate repeatedly extracted with ether. Phloroglucin crystallises from the ethereal solution.

Formation of Ozone by Hydrocarbons.—J. Schiel.—It has been observed that the alkaline metals, thallium, &c., do not retain their brightness if kept in a stoppered bottle under rock oil. The author proves that this action is due to the formation of ozone.

On Fermentation.—J. Schiel.—The author passed the current of two zinc carbon elements through a solution of sugar, mixed with yeast, juice of meat, and a little ammonium phosphate. The fermentation proceeded as usual, but the formation of bacteria was prevented.

Action of Nitrous Acid upon Tin-phenyl-chloride.—B. Aronheim.—The compound obtained was identical with tin-triphenyl-chloride. Nitroso-benzol was also produced.

Action of Gaseous Chlorine upon the Hydrates of Baryta and Strontia (II.).—J. Konigel-Weisberg.—In this memoir the author describes the action of chlorine upon hydrate of strontia containing different proportions of water.

Action of Nitrous Anhydride upon Proto-catechuic Acid.—Max Gruber.—The products obtained were oxalic and picric acids, carboxy-tartronic acid, dinitrodioxy-quinon, α-dinitro-phenol, and nitro oxy-benzoic acid.

Methyl Derivatives of Para-phenylen-diamin.—C. Wurster.—An examination of dimethyl-para-phenylendiamin, its acetyl derivative, and of the tetra-methyl compound.

On Nitro-dimethyl-anilin.—C. Wurster.—Nitrosodimethyl-anilin is readily converted into nitro-dimethylanilin by the action of oxidising agents. The author confirms Weber's account of its preparation.

Ureas of Dimethyl-para-phenylen-diamin. — F. Binder.—The author has obtained and described two ureas, a mono and a di compound.

MISCELLANEOUS.

University of London.—The following are lists of the candidates who have passed the recent B.Sc. examination:—First B.Sc. Examination: Pass List (*First Division*).—T. J. Bowlker, private study; J. S. W. Chitty, Magdalen College, Oxford; T. R. Dallmeyer, University College and private study; G. L. V. Fairibault, Catholic University College, Kensington; P. F. Frankland, Royal School of Mines and private study; E. T. Glasspool, M.A., private study; W. L. Goodwin, University of Edinburgh; C. Grimshaw, Owens College and private tuition; S. F. Harmer, University College; G. W. Hill, King's College and St. George's Hospital; W. Law, private study; R. B. Lee, private study; C. Myhill, University College and private tuition; W. Odling, Royal School of Mines; F. W. Payne, B.A., Brighton Grammar School; W. J. C. Ross, King's College and private study; J. Ryan, Unattached, Cambridge; G. P. Simpson, private tuition; A. Smithells, Owens College; A. K. A. Spiegel, Owens College; A. F. Stoddart, University College, Bristol; Ellen Martha Watson, private study; S. Young, Owens College. (*Second Division.*)—W. Bryant, B.A., private study; R. Frost, Owens College; J. R. Green, private study; Catherine Alice Raisin, private study; G. A. T. Walton, St. Bartholomew's Hospital; H. Wilson, The Leys School, Cambridge. (*Mathematics only.*)—W. J. Collins, St. Bartholomew's Hospital; A. Newsholme, St. Thomas's Hospital.

Letters Patent for Colouring Matters.—A patent case of some interest was argued before the Lord Chancellor on the 30th ult. Mr. Frank Wirth, of Frankfort, petitioned that the seal might be affixed to letters patent for an invention for "Improvements in colouring matters, and in the manufacture of the same," communicated to him by Messrs. Meister, Lucius, and Brüning, of Höchst, Germany. It appeared that the improvements consisted substantially in the preparation of colouring matters by the reaction of diazo compounds of phenols upon the disulpho acids of beta-naphthol. The application was opposed by Dr. J. P. Griess, F.R.S., of Burton-on-Trent, chiefly on the ground that the applicant's invention was already covered by previous letters patent granted to him, the opponent. These letters patent were respectively dated the 4th of October, 1877, No. 3698, and the 20th of November, 1878, No. 4726, and it appeared, from the specifications of these letters patent, that Dr. Griess had, in fact, patented the preparation of colouring matters by acting upon the diazo compounds of phenols and phenolic ethers with, among other things, disulpho acid of beta-naphthol. It was, however, pointed out on behalf of the applicant that the latter did not claim to use the disulpho acid of beta-naphthol as used by Dr. Griess under his letters patent, but one or other of the two isomeric disulpho acids of beta-naphthol which Messrs. Meister, Lucius, and Brüning had been the first to discover, and the separation of which and their respective application or treatment with certain other substances, such as toluydin and xylodin, Mr. Wirth had been the first to patent, that is to say, on the 29th April, 1878, No. 1715. It appeared that these isomeric disulpho acids were capable of reactions different from those resulting from the use of the disulpho acid described in the specifications of Dr. Griess. The application for letters patent by Mr. Wirth had been accompanied by the usual statutory declaration, which, however, had been declared at Frankfort before H.B.M. Consul. The objections filed on behalf of Dr. Griess were in substance (1) that F. Wirth was not the true and first inventor or importer of the alleged invention, and (2) that the alleged invention was wholly or in part covered by the letters patent of Griess. By his affidavit in opposition the latter had also objected that Wirth had not made and could not make at Frankfort a declaration that would be good under British patent or other law. There had been no opposition before the law officer. Upon the petition being called on, Mr. Aston, Q.C., urged as a preliminary objection that Wirth's application was void *ab initio*, on the ground that a declaration such as that required by the Patent Law Amendment Act could not be made by a foreigner resident abroad before the British Consul, contending that the statutory forms were not merely directory but imperative. Moreover, Wirth, being a resident abroad, could not receive a communication from other foreigners also abroad, and receive a British patent as for an imported invention. The Lord Chancellor was of opinion that letters patent might be granted to a foreigner resident abroad for an invention communicated to him by another foreigner also resident abroad. The petition was then opened and heard upon the merits. Affidavits by Professor Odling, F.R.S., and Professor Armstrong, F.R.S., were read on behalf of the opponent, and ultimately it was arranged that the letters patent of the applicant should be sealed upon his undertaking to insert in his specification a disclaimer of any matters covered by the letters patent granted to Dr. Griess, and no order was made as to costs.

TO CORRESPONDENTS.

W. J. Reynolds.—Mix the paint with gelatine and water instead o oil.

M. T. D.—The address was printed just as it was received from Messrs. W. H. Smith and Son.

THE CHEMICAL NEWS.

Vol. XL. No. 1029.

DECOMPOSITION OF CHLORINE.

Since the publication of Prof. Meyer's important researches on chlorine in the Chemical News of August 1, we have obtained some additional particulars, which we hasten to lay before our readers. The vapour-density apparatus designed by Prof. Meyer, and referred to by Mr. Watson Smith, has already been shown in the Chemical News (vol. xxxix., p. 66), and it was by means of this apparatus, suspended in a Perrot's furnace, we believe, that the oxygen was obtained. In his note Mr. Watson Smith said that, "Experimental evidence appears to indicate beyond a doubt that to all appearance ("*Moglicherweise*" is the word Victor Meyer wishes at present to be used) by heating chlorine oxygen can be obtained." The chlorine was prepared absolutely pure by heating $PtCl_2$ (or Pt_2Cl_4), and was dried with every precaution, being passed over $CaCl_2$, through SO_4H_2, and over a layer of P_2O_5 one metre in length; it was then passed into the vapour-density apparatus, in the lower portion of which porcelain was substituted for glass. The dissociated chlorine gas issuing out of the small tube *a* and containing oxygen was absorbed by passing through KI solution. The oxygen passing through unabsorbed was collected, and the usual tests were applied.

SYNTHESIS OF PHENYL-NAPHTHALENE.

By WATSON SMITH, F.C.S., F.I.C.

In my last papers, or rather preliminary notes, on the above subject (see Chemical News, vol. xl., p. 3; also *Ber. der Deutsch, Chem. Gesell.*, xii., p. 1396) I described a method by which iso-dinaphthyl, diphenyl, and a new hydrocarbon—probably phenyl-naphthalene—were formed together, and could readily be separated by fractional distillation, and by subsequent treatment of the crude new substance with boiling dilute spirits of wine the new hydrocarbon was dissolved out, but the iso-dinaphthyl mostly remained insoluble. On sublimation the new body was easily obtained quite pure, and formed beautiful small plates with blue fluorescence, the vapours possessing a most pleasant odour of oranges. In the above case the calculated quantities of brom-benzene and naphthalene were passed through the red-hot tube. The experiment was now conducted differently, soda-lime being introduced into the tube instead of pumice-stone. It was now found that the reaction proceeded much *less* favourably, and that benzene was formed and came over, no doubt with a certain quantity of diphenyl. This reaction is analogous to that previously described (Chemical News, vol. xl., p. 3), in which brom-naphthalene and benzene were passed over soda-lime, and naphthalene was formed. The former method was therefore adhered to, but I determined to modify the proportions, so as, if possible, to make use of the tendency to form diphenyl so as to yield me rather an increased yield of phenyl-naphthalene. This was effected by employing in the next mixture used a certain excess of naphthalene over the calculated quantity. The soft tarry-looking mass was then distilled, and the unaltered brom-benzene and naphthalene coming over, after being mixed with more naphthalene, were passed again through the red-hot tube. This was continued till but little undecomposed brom-benzene passed over, or till it was almost all decomposed. On subjecting the mixture of high boiling residues thus obtained to distillation, unaltered naphthalin, very little diphenyl, a greatly increased quantity of phenyl-naphthalene, and iso-dinaphthyl, with still higher boiling products, came over. The amount of phenyl-naphthalene now obtained was equal to, if not larger than, that of the dinaphthyl formed—a vast improvement on the results of the former methods.

A combustion was now made of the purified substance, with the following results:—

	Found.	Calculated for $\begin{matrix}C_{10}H_7\\ \vert\\ C_6H_5\end{matrix}$
Carbon	94·63	94·12
Hydrogen	6·01	5·88

Two vapour-density determinations were also made according to the method of Victor Meyer and Carl Meyer, and these were conducted conjointly with my friend Carl Meyer with the utmost care and exactitude. We made the determinations in an atmosphere of nitrogen, and obtained the following results:—

$$\begin{array}{lcl} \text{I.} & & \text{II.} \\ \left.\begin{array}{l} B=722{\cdot}8 \\ w=\ 24{\cdot}3 \\ t\ =\ 25{\cdot}5^{\circ} \\ S=0{\cdot}1336 \\ V=17{\cdot}3\text{ c.c.} \end{array}\right\} & \begin{array}{l} B=\text{barometric column at }0^{\circ} \\ w=\text{tension of aq. vapour for }t^{\circ} \\ S=\text{weight of substance taken} \\ V=\text{vol. in c.c. of displaced air} \\ d=\text{vapour-density} \end{array} & \left\{\begin{array}{l} B=722{\cdot}8 \\ w=\ 24{\cdot}3 \\ t\ =\ 25{\cdot}5^{\circ} \\ S=0{\cdot}13825 \\ V=17{\cdot}8\text{c.c.} \end{array}\right. \end{array}$$

$$d=\frac{S(1+0{\cdot}003665\,t)587780}{(B-w)V}$$

Hence—

Vapour-density.

Found. Cal. for $\begin{matrix}C_{10}H_7\\ \vert\\ C_6H_5\end{matrix}$

$$\left.\begin{array}{ll} \text{(I.)}\ \ldots & \dfrac{0{\cdot}1336(1+0{\cdot}003665{\cdot}25{\cdot}5)587780}{(722{\cdot}8-24{\cdot}3)17{\cdot}3}=7{\cdot}10 \\ \text{(II.)}\ \ldots & \dfrac{0{\cdot}13825(1+0{\cdot}003665{\cdot}25{\cdot}5)587780}{722{\cdot}8-24{\cdot}3)17{\cdot}3}=7{\cdot}14 \end{array}\right\}\ 7{\cdot}05$$

The melting-point was now re-determined with great care, using one of Giessler's normal thermometers; it was found to be 95° as the mean of several determinations, and this must be regarded, then, as the corrected melting-point, that first given (101° to 102°) having been determined with an ordinary instrument. This latter thermometer, with the freshly-prepared substance, indicated 100° to 101°; hence showing that a substance practically of a constant composition—in fact, the same body—had been obtained as that tested in the first case.

A combustion was now made again, but of the very substances which had been the subjects of the two vapour-density determinations. The contents of the glass vapour-density apparatus (Meyer's), were treated with hot absolute alcohol, well shaken, and then thrown on to a filter. The fine white sand (used to break the fall of the little tube with substance), remained, and the alcoholic solution of the phenyl-naphthalene passing through, was diluted with much water, which precipitated the phenyl-naphthalene in small microscopic and pure white plates. This, after washing with water, was dried at 70° in the air-bath, and analysed. 0·23925 grm. substance gave 0·1185 water and 0·82795 grm. carbon dioxide:—

	Found.	Calculated.
Carbon	94·37	94·12
Hydrogen..	5·51	5·88
	99·88	100·00

In the process of preparation it would seem, then, that when the calculated quantities of brom-benzene and naphthalene are taken, mixed, and passed once through the red-hot tube, the following reactions take place together:—

$$(1.)\ \left\{\begin{matrix} C_{10}H_7 \\ C_{10}H_7 \end{matrix}\right. \boxed{\begin{matrix} H + Br \\ H + Br \end{matrix}} \left.\begin{matrix} C_6H_5 \\ C_6H_5 \end{matrix}\right\}$$

Dinaphthyl. Diphenyl.

$$(2.)\ \underline{C_{10}H_7 \ \boxed{H + Br} \ C_6H_5}$$

Phenyl-naphthalene.

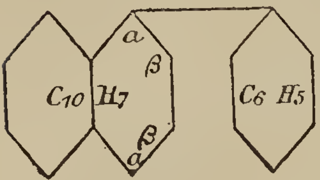
But on using an excess of naphthalene, and passing the undecomposed brom-benzene and naphthalene, with the addition of a little more naphthalene, through the red-hot tube till all brom-benzene disappears, it would seem that reaction (1) ceases to a considerable extent, and for the most part, in fact, reaction (2) now predominating, together with the simpler one,—

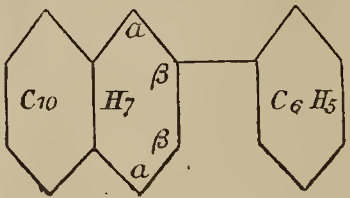
$$\left\{\begin{matrix} C_{10}H_7 \\ C_{10}H_7 \end{matrix}\right. \boxed{\begin{matrix} H \\ H \end{matrix}}$$

Dinaphthyl.

resulting by the action of heat on the excess of naphthalene, and hence accounting for the presence in the reaction-product of so considerable a quantity of iso-dinaphthyl, with scarcely any diphenyl.

There are two isomerides of phenyl-naphthalene possible, viz., the *α* and the *β* :—





It is interesting to ascertain which isomer represents the new hydrocarbon obtained. I think there can be little doubt it is the *β*-phenyl-naphthalene, and for the following reason. It is formed from that naphthyl residue of a naphthalene group, which is itself formed at a high temperature the most readily and easily. Now, by the action of heat alone, or heat in conjunction with halogenic action, if the term may be allowed, *upon naphthalene*, my previous investigations have shown that iso-dinaphthyl is formed in preponderating quantity, and that iso-dinaphthyl is in the highest degree of probability the *ββ*-dinaphthyl, hence the phenyl-naphthalene is in all probability the *β*-isomeride. It is not at all improbable the *α*-isomeride may be obtainable by means of Fittig's reaction, with a mixture of *α*-brom-naphthalene and *α*-brom-benzene; thus—

$$\underline{C_{10}H_7 \ \overset{\alpha}{\boxed{Br + Na}} \quad \overset{\alpha}{\boxed{Na + Br}} \ C_6H_5}$$

α-phenyl-naphthalene.

This question I shall next proceed to solve, together with the following:—"Is it not possible to obtain a diphenyl-naphthalene by the action, say, of two molecules of brom-benzene on one of naphthalene on passing the mixture through the red-hot tube?" Thus—

$$\underline{C_6H_5 \ \boxed{Br + H}} \ \underline{C_{10}H_6 \ \boxed{H + Br} \ C_6H_5}$$

Diphenyl-naphthalene.

or by the action of 2 mols. benzene on 1 of dibrom-naphthalene,—

Diphenyl-naphthalene.

$$\overline{C_6H_5 \ \boxed{H + Br}} \ \overline{C_{10}H_6 \ \boxed{Br + H} \ C_6H_5}$$

Or it is possible, by using a mixture of 1 mol. dibrom-benzene and 2 mols. of naphthalene, that dinaphthyl-benzene may be obtained:—

$$\underline{C_{10}H_7 \ \boxed{H + Br}} \ \underline{C_6H_4 \ \boxed{Br + H} \ C_{10}H_7}$$

Dinaphthyl-benzene.

Indeed, I am proceeding to examine the higher boiling-products obtained, with the dinaphthyl and phenyl-naphthalene, when excess of naphthalene was used, to see if small quantities, at least, of the above hydrocarbon be not already present. The solution of these latter problems will form a considerable portion of my future work.

University Laboratory, Zürich,
August 4, 1879.

UPON AMMONIUM NITRITE, AND UPON THE BY-PRODUCTS OBTAINED IN THE OZONISATION OF AIR BY MOIST PHOSPHORUS.

By ALBERT R. LEEDS.

As long ago as 1848, Dr. T. Sterry Hunt threw out the suggestion, that the nitrogen of the atmosphere is really composed of two equivalents of the element, sustaining towards each other the same relations as the two equivalents in nitrous oxide. He supposed that the group NNO is not a simple oxide, but an anhydrous amide, or nitryl, derived from the ammonium nitrate by the removal of $2H_2O$, and capable, when passed over a mixture of lime and potash at a sufficiently high temperature, of regenerating ammonia and a nitrate.* He insisted upon the parallelism between this case and that of ammonium nitrite which undergoes a precisely similar decomposition under the influence of heat, losing $2H_2O$ and evolving NN, nitrogen gas. It would appear that Prof. G. C. Schaeffer had independently arrived at a similar conclusion concerning the dual nature of nitrogen, holding the same view as Dr. Hunt, that it is the nitryl of ammonium nitrite, and capable of forming this body by assuming again the elements of water.†

In 1862, Schönbein published an extensive series of experiments upon the generation of ammonium nitrite from water and atmospheric air under the influence of heat.‡ Unacquainted, apparently, with speculations by which the formation of ammonium nitrite in this manner had been anticipated on theoretical grounds, he announced his own discovery as in the highest degree remarkable and hitherto entirely unexpected. He states that his own labours in this direction were animated by the consideration that this salt is so readily decomposed under the influence of heat, into water and nitrogen, that it might, under suitable circumstances, be likewise readily regenerated from the same bodies. These circumstances he found to consist in the contact of water, converted into vapour at various temperatures, with atmospheric air, and attributed the combination principally to the heat employed. No other phenomena, according to Schönbein, were concerned in the generation of ammonium nitrite under these circumstances, and those which regulate its formation when various bodies, like hydrogen, hydrocarbons, fats, wood, coal, &c., were burned in air.

It is not necessary to enter into the details of his experiments, further than to remark, that in none of them, apparently, was the precaution taken to use air which had been purified from its pre-existent ammoniacal and nitrous compounds. This manifest source of error was at once pointed out by Bohlig,§ who never succeeded, in whatever way or at whatever temperatures, the experiment was conducted, in obtaining the reactions of ammonium nitrite when purified air was employed, but readily obtained

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* *American Journ. Sci.*, May, 1848, p. 407.

† "Chemical and Geological Essays," T. S. Hunt, 2nd Ed., p. 472

‡ *Ann. der Chem. und Pharm.*, 1862, vol. cxxiv., p. 1.

§ *Ann. der Chem. und Pharm.* 1863, vol. cxxv., p. 21.

them when, under like conditions, common air was used. In opposition to these results of Bohlig, Prof. Liebig maintained in the same journal, the trustworthiness of Schönbein's observations, contending that the fact was sufficiently proven by the very numerous and varied experiments of Schönbein, and disregarding the valid objection, that in none of these same experiments had purified air been employed. Even to the present day the generation of ammonium nitrite from atmospheric air and water by the aid of heat, is taught in text-books as an admitted fact, and that, too, after Zabelin, in 1864,[*] and Carius,[†] ten years later, had repeated, with exceeding care, and verified Bohlig's observations. In particular, Carius employed most elaborate precautions, using only air and water which had been most carefully purified. The water was evaporated both with a rapid and a slow change of atmosphere; at various temperatures, from the common to 100°; both alone and after addition of baryta, the baryta being devoid of nitrogen compounds; in contact with platinum spirals, and diffused over a great surface of purified cotton-wool—in no case was ammonium nitrite formed.[‡]

It is of the highest importance, therefore:

I. To exclude the possibility of the conversion of water under the influence of heat in contact with atmospheric air, from among the number of possible sources of ammonium nitrite and nitrous compounds.

II. In cases of rapid oxidation, like the combustion of H,[§] hydrocarbons,[‖] fats, phosphorus,[¶] and other bodies in the air, if it be true that ammonium nitrite is formed, irrespective of any nitrogen compounds pre-existent in the atmosphere, the origin of this ammonium nitrite is to be looked for in other causes than the conjunction of atmospheric air and water-vapour under the influence of heat.[*]

III. The same remark applies if any ammonium nitrite is formed by the slow oxidation of phosphorus in contact with air and water. The very numerous and laborious experiments by which Schönbein appears to have established the fact of the formation of ammonium nitrite under these circumstances, have caused its universal acceptance.[†] Bohlig, following Schönbein, attributed the production of ammonium nitrite during the slow oxidation of moist phosphorus, to the action of the ozone formed at the same time. Carius, by elaborate proofs, has demonstrated that ozone, which was prepared by electrolysis in such a manner as to be entirely free from nitrogen compounds, and even from hydrogen gas, was entirely devoid of action upon nitrogen in the presence of vapour of water. In order to make the experiments comparable to those in which ozone is liberated at the same time with a disengagement of heat, as in the case of the electrical discharge, the ozone was brought by Carius into contact with nitrogen and water-vapour at all temperatures short of those at which ozone undergoes dissociation into ordinary oxygen—in every case with negative results. The ozone prepared by electrolysis was preferred to that obtained by the electrical discharge, since, as both Soret[‡] and Carius have shown, ordinary oxygen prepared from potassium chlorate, and containing from 1 to 2 per cent of nitrogen, yields, when ozonised by the electrical discharge, small but determinable amounts of nitrous acid. Still later, Berthelot[§] has investigated the accuracy of the statement made by Schönbein,[‖] that ozone combines with free nitrogen, in presence of alkalies, at ordinary temperatures, to form nitrous compounds.

Schönbein found in 3000 litres of air, powerfully ozonised by phosphorus, then washed with water, the washings treated with lime water, and the resulting calcium compound decomposed by potassium carbonate, an amount of nitric acid corresponding to 5 grms. of nitre. Berthelot collected in a number of flasks over water, oxygen ozonised by the silent discharge, until the flasks were three-fourths filled. The surplus water was then allowed to run out completely, its place being supplied by atmospheric air, and some pure baryta water introduced in each flask. After standing over night, all traces of ozone had completely disappeared. But the baryta water contained no traces of nitrogen compounds; the wash-water did. Similar results were obtained with the air ozonised by phosphorus, and completely washed before contact with baryta water.

Quite independently of the work done by other observers, an extended series of experiments had been instituted upon the phenomena which accompanied the ozonisation of moist air by means of phosphorus. In the earlier trials, attention was limited to the question whether oxidised compounds of nitrogen were produced or no. Subsequently the research was made to include all other by-products. It was deemed important to purify and measure the air used and the ozone formed; to determine the amount of phosphorus consumed, and of phosphoric and phosphorous acid produced; and, in case they were really present and it were possible to estimate them, the amounts of nitrogen compounds, of hydrogen peroxide and ozone, remaining in solution in the jar- and wash-waters. Lest it be thought needless to have re-investigated these points the following reasons for so doing may be mentioned:—

I. Preliminary trials had shown that, if formed at all,

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[*] *Ann. der Chem. und Pharm.*, cxxx., p. 82.

[†] *Ann. der Chem. und Pharm.*, clxxiv., p. 1.

[‡] Note.—Since the above was written a paper has been published by A. v. Loesicke (*Arch. Pharm.* [3], 14, 54 to 58, and *Chemiker Zeitung*, No 9, 1879). Inasmuch as I have no access to either of these journals, I can only quote from the abstracts (*Journ. Chem. Soc.*, April, 1879, p. 298; Chemical News, vol. xxxix., p. 150). It is stated in the *Journ. Chem. Soc.* abstract, that "the author has corroborated Schönbein's statement, that the evaporation of water in air produces ammonium nitrite, and gives the results of experiments to determine the conditions of its formation. It is found that ammonium nitrite is always formed when water evaporates freely, and the lower the temperature, the larger is the quantity produced; but the formation is prevented if the evaporation takes place in a narrow-necked flask. In another series of experiments it was observed that 1 litre of water, evaporated to a small bulk, yielded ammonia equivalent to 0·148 part in 100,000 parts of water; 1 litre, evaporated to small bulk at 40° to 50°, yielded ammonia equivalent to 0·5823 part of nitric acid per 100,000 of water; and, lastly, 5 litres of water, allowed to evaporate spontaneously, yielded ammonia equivalent to 2·9608 nitric acid per 100,000 parts of water. This last experiment shows the influence that the evaporation of rain-water and dew can have on the nourishment of plants; and it has been found that if a leaf be moistened and allowed to dry, nitrous acid is produced, and that in dew from leaves, ammonium nitrite can be easily detected."

With reference to these observations it is to be remarked:—1st. In the absence of any reference to the esssential precautions of excluding the access of nitrogenised atmospheric particles, atmospheric ammonia, and nitrous compounds, it is fair to infer that these precautions were not taken, and in that case, the experiments of Bohlig, Zabelin, and Carius, which contradict the hypothesis of Schönbein, must be regarded as unshaken and conclusive. 2nd. The rise of temperature, especially under such circumstances as would establish a current of vapour from the surface of the liquid, would diminish the rate of absorption of nitrogenous bodies from the surrounding atmosphere. Cooling the evaporating liquids would operate in a two-fold manner; in the first place, by augmenting the coefficient of solubility of the atmospheric ammoniacal compounds; and, secondly, by greatly increasing the length of time required for the spontaneous evaporation of so large a bulk as 5 litres of water.

To get rid of all traces of ammonia upon the surfaces of vessels is a problem of almost insuperable difficulty so long as laboratory operations must be performed in common air. In this connection we would call to mind the experiments of Faraday (*Quart. Journ. Science*, xix., 16), who was greatly perplexed by obtaining ammonia, on heating hydrogen gas in contact with potassium and zinc. The vessels and substances had been purified, and every precaution exercised, which the almost matchless skill of that incomparable experimental philosopher could devise, and yet Faraday abandoned the research, confessing his inability to satisfactorily account for the appearance of ammonia under these circumstances. Additions to our knowledge since that time may render it not presumptuous to suggest the cause above given.

[§] Saussure (*Annales de Chemie*, lxxi., 282).

[‖] Böttger (*Jahresb. der Phys. Vereins, zu Frankfurt a.M.*, 1860, 1861, p. 69).

[¶] Schönbein (*Ann. der Chem. and Pharm.*, vol. cxxiv., p. 6).

[*] In the case of hydrogen, Zöller and Grete have shown, by the burning of very large volumes of perfectly pure hydrogen in completely purified air, that small amounts of ammonium nitrite are produced, and have demonstrated the presence of ammonia and nitrous acids in the water formed in the course of the combustion, by many concordant and quite satisfactory tests.—(*Berichte der Deutsch. Chem. Gesell.*, 1877, vol. x., pp. 2, 144.)

[†] See Carius, *Ann. der Chem. und Pharm.*, 1874, vol. clxxiv. p. 43.

[‡] *Comptes Rendus*, lvi., 390.

[§] *Comptes Rendus*, 1877, lxxxiv., 61.

[‖] *Denkschrift über das Ozon* p. 16 Basel, October, 1849.

there were grounds for supposing that these products were comparable in minuteness to the nitrogen compounds pre-existent in the atmosphere.

II. Since the time of Schönbein, the experiments of Goppelsröder and Carius had shown that the ozonisation of ammonia would produce ammonium nitrite and nitrate and hydrogen peroxide.

III. We could not discover that in experiments previously made upon the ozonisation of air by phosphorus, the air had been previously purified.

IV. It was important to determine whether any ammonia or nitrous acid existed at the close of the operation, or whether they were completely oxidised to nitric acid. The explanations of the reactions would depend largely upon the determination of these factors.

The phosphorus ozonator (described in the *Journal of the American Chemical Society*, vol i., p. 8) was employed throughout the whole course of this investigation. In the first series of experiments ordinary air drawn from outside the laboratory was used. The jars in some cases contained common distilled water, in other cases the bichromate mixture made as described in article alluded to. The ozonised air was aspirated through the kerite tubing, from the last bell, into a wash-bottle containing *aqua puriss.* (re-distilled and free from every trace of ammonia), and then into one or more Peligot tubes containing neutral solution of potassium iodide. Only on titration was the solution of potassium iodide made acid. The reason for this precaution is given in the *Journ. Amer. Chem. Soc.*, vol. i., p. 78, where it is shown that a stream of air or oxygen passing through an acidified solution of potassium iodide, greatly increases the amount of iodide set free. The nitric acid in the wash-bottle was determined by reduction with pig-iron, the precautions being employed which are stated (*Proceedings Amer. Chem. Soc.*, vol. ii., No. 4, 1878).

TABLE I.

Nitric Acid Formed with Non-purified Air.

Air Used. Litre.	Total Ozone in Mgrm.	Total Ozone in C.c.	V. p.c. of Air.	Total HNO_3.	HNO_3 P.c.
27 (over H_2O)	—	—	—	0·111	0·000318
108 ,, ,,	—	—	—	0·444	0·000318
45 (over CrO_3)	13·61	6·37	0·014	0·314	0·00054
85 (over H_2O)	77·07	36·09	0·039	0·333	0·000303
90 (over CrO_3)	71·91	33·67	0·037	0·610	0·00054

In the following trials, the air was purified by aspiration through a tube one-half metre in length, packed with cotton-wool, then through three Peligot tubes, the first containing *aqua puriss.*, the second soda solution, the third sulphuric acid. The soda employed in this and other trials was some made from sodium, and which had been repeatedly proven to be free from nitrogenous bodies. The sulphuric acid yielded to meta-diamido-benzol no trace of nitrous acid, nor any ammonia on neutralisation and reduction. Ordinary distilled water was employed in the jars.

TABLE II.

Nitric Acid Formed with Purified Air (Aqua Pur.).

Air Used. Litres.	Total Ozone. Mgrms.	Total Ozone. C.c.	V. p.c. of Air.	Total HNO_3. Mgrms.	HNO_3 P.c.
262 (over H_2O)	261·8	104·16	0·04	1·11	0·000328

In an experiment similarly arranged, except that hydrant water was used in the jars, 0·3964 grm. of ozone was produced. The wash-water contained 0·37 mgrm. of nitric acid, and 1·3 mgrms. of hydrogen peroxide. The latter would correspond to 0·00039 per cent of the total weight of the air used.

In the foregoing experiments, the percentage of nitric acid as compared with the weight of the air passed over, appears quite constant. This is true whether water or bichromate mixture was employed, although with the latter the percentage was somewhat higher. The ozone had been manufactured for a variety of purposes, and these percentages were not calculated until after all the determinations were concluded, when an unexpected closeness of agreement between the results was developed. Although this agreement pointed to a constantly operating cause, yet, by reason of the extreme minuteness of the amounts of nitric acid, it was deemed safer provisionally to assume that the agreement was really due to a constant source of error. A scheme was therefore drawn up, which should include the sources of error and the substances to be determined to the best of our knowledge, As others may detect features in which our methods were at fault, or essential precautions were overlooked, this scheme is given below:—

I. Use of a measured amount of *aqua puriss.*, in the jars.

II. Complete straining and washing of the air by means of cotton-wool, *aqua puriss.*, NaOH and H_2SO_4, both shown to be free from nitrogen.

III. Weight of phosphorus cakes before and after the experiment.

IV. Amount of ammonia in the jar-water at close of experiment.

V. Also of the nitrites and nitrates, as determined by reduction.

VI. Amount of nitrous acid, as determined by meta-diamido-benzol.

VII. Amounts of phosphoric and phosphorous acids and of hydrogen peroxide in the jar-water.

VIII. Estimation of H_3N, (HNO_3 and HNO_2), HNO_2, H_3PO_4, H_3PO_3, and H_2O_2, in the wash-water after ozonising ("ozone wash-water").

IX. Similar estimations, except of the phosphorus compounds, in the solutions employed to wash the air ("air wash-water").

X. Measurement of total volumes of air used, and of ozone after its escape from the ozone wash-water.

In order to compensate for the increase of suction necessitated by so many wash-bottles, the standards and discs carrying the phosphorus were raised nearly to top of the bells.

This required the employment of 11 litres of *aqua puriss.* in the jars. After 420 litres of air had been aspirated the jar-water was poured into three tall cylinders, the precipitate, mostly lead phosphate, allowed to settle, and the water and precipitate analysed separately. The weight of the phosphorus cakes at beginning of the experiment was 111·646 grms., at the close 54·284 grms. The total amount of ozone which passed out of the ozone wash-bottle, was 0·8046 grm., or an average of 1·92 mgrms. ozone per litre of air, the temperature varying during the course of the six days consumed in the experiment between 18° and 21°. This would correspond to 71·29 grms. of phosphorus consumed for each gramme of ozone produced. Probably the consumption would be in a somewhat different ratio at the temperature of maximum evolution (24°), and with bichromate mixture in the jars.

Phosphoric and Phosphorous Acids.

The amount of phosphoric acid (H_3PO_4) existing in solution in the jar-water, was 178·02 grms.; in combination with the lead as triplumbic phosphate, 0·939 grm.; and the comparatively small amount carried over into the ozone wash-water was 0·252 grm., making a total of 179·24 grms.

The large amount of phosphoric acid is itself a valuable product, and capable either of being used directly or of being easily re-converted into phosphorus. Hence, its formation cannot be considered as a drawback upon this method of ozonising. The phosphorous acid in the jar-water was 2·57 grms., in the ozone wash-water, 0·013 grm.

Ammonia, Nitrous and Nitric Acids.

(*a.*) *In Air Wash-water.*—The entire ammonia derived from washing 420 litres of air, was 0·03 mgrm., corresponding to 6 parts in 100 million. No nitrous acid could be detected by means of meta-diamido-benzol; nitric acid not determined.

(*b*.) *In Jar-water.*—50 c.c. of the jar-water rendered alkaline with pure soda, and distilled in a purified retort, yielded 0·08 mgrm. H_3N, corresponding to 17·60 mgrms. ammonia in the 11 litres. A like portion, similarly treated, gave, on reduction with pig-iron, 0·14 mgrm. H_3N, or in the total jar-water, 0·0308 grm. Both NH_4NO_2 and NH_4NO_3 should yield on reduction twice the amount of ammonia which they give when the ammonia is determined directly. In the above determination, the amount which was found falls short of the theoretical by a difference quite within the errors of experiment.

Since phosphorous acid was contained in the jar-water, it became important to determine whether this body, when distilled in neutral or slightly alkaline solution, with pig-iron, would yield a distillate capable of effecting the Nessler reagent. Some phosphorous acid was therefore prepared from phosphorus trichloride, and the experiment tried, but the results obtained negatived the above hypothesis.

No nitrous acid was detected. The nitric acid, as deduced from the ammonia found directly and after reduction amounted to 0·0489 grm., or 0·0089 per cent of the total weight of the air used.

(*c*.) *In Ozone Wash-water.*—The ammonia obtained by direct distillation amounted to 0·075 mgrm.; by reduction, to 0·315 mgrm.; this would leave for the ammonia, corresponding to the nitric acid, 0·24 mgrm. (equivalent to 0·88 mgrm. HNO_3), a result three times greater than the ammonia corresponding to the base, instead of twice, as should have been.

No nitrous acid was found by the use of meta-diamidobenzol.

Hydrogen Peroxide.

The ozone wash-water contained 2·01 mgrm. hydrogen peroxide, or 0·00037 per cent of the total weight of the air passed over. The nitric acid contained in the ozone wash-water, was only 0·000162, or about one-half the percentage of the hydrogen peroxide.[*]

Final Experiment.—The failure to find in the jar-water an amount of ammonia, on reduction, which would exactly correspond to the nitric acid required to form with the basic ammonia, ammonium nitrate, cast some suspicion on the above results. A final experiment was therefore instituted, in order to settle positively whether any ammonium nitrite could be detected at the close of the operation, and whether all the nitric acid found existed in combination as ammonium nitrate.

Renewed precautions were therefore instituted to purify the air employed—two columns of glass beads saturated with H_2SO_4 being employed in addition to the wash-bottles mentioned in the former trials. The air was forced by a tromp through this long series of purifiers into the ozonator, and drawn out again through the wash-bottles used to wash and titrate the products, by means of a water air-pump. By this means, the phosphorus cakes were always kept immersed to the same depth in the jar-water. Sliding standards had been discarded in the improved form of ozonator now employed, and the cakes were supported on leaden discs which rested upon little leaden brackets, passing through holes drilled through the sides of the bells, at a small distance above their lower rims. 4850 c.c. *aqua puriss.* were used in the jars; the amount of air passed through the apparatus was 481 litres; the ozone discharged from the ozone wash-water, 0·924 grm. The following table presents a synopsis of the results obtained:—

Table III.

Ammonia.		HNO_2.	HNO_3.	NH_4NO_2.	NH_4NO_3.
Before Reduction.	After.				
		Air Wash-water.			
Mgrm.	Mgrm.	Mgrm.	Mgrm.	Mgrm.	Mgrm.
0·10	0·15	0·065	0·104	0·092	0·132
		Corresponding in 100 Million Parts.			
Parts.		Parts.	Parts.	Parts.	Parts.
16	None.	10	17	15	20
		Jar-water.			
Mgrms.	Mgrms.		Mgrms.		Mgrms.
(1.) 7·76					
(2.) 4·82	11·64	None.	21·57	None.	27·39
		Ozone Wash-water.			
0·066	0·198	None.	0·49	None.	0·31

It will be noted that the ammonia washed out of the atmospheric air is somewhat in excess of that required to neutralise the nitric and nitrous acids, and it may be queried whether this excess existed in some other form of combination, as the carbonate.

The determination marked (1) of ammonia in the jar-water, was made upon 50 c.c. Subsequently the same apparatus was employed as that ordinarily used in water analysis, and after the large amount of soda required to render 500 c.c. of the jar-water alkaline, was repeatedly distilled with *aqua puriss.* until it gave no further reaction of ammonia, the 500 c.c. was added, and the distillations continued. This determination corresponded to 5·82 mgrms. H_3N in the total jar-water, and is just one-half the amount obtained after reduction. Since the absence of nitrous acid was proven, this result goes far to demonstrate that the ammonia derived from the jar-water, existed there as ammonium nitrate.

But in the ozone wash-water, instead of being one-half, it is only one-third of the amount found on reduction, a result corresponding with that found in the former trial.

Hydrogen Peroxide.—As determined directly upon one portion of the ozone wash-water, this amounted to 2·7 mgrms.; determined after evaporating 30 c.c. down to 3 c.c., it amounted to 2·4 mgrms. The estimation was made by means of sodium hyposulphite and potassium iodide. These reagents could be safely made use of, since the absence of nitrous acid had been previously proven. It was likewise found that the presence of phosphorus acid had no effect upon the titration. If the larger result obtained on titrating directly be attributed to dissolved ozone, then the amount of ozone in solution would have been 0·44 mgrm. Since, however, the percentage of hydrogen peroxide is diminished by concentration with the aid of heat, the lower result obtained after evaporation, might, perhaps, be more satisfactorily attributed to the loss of hydrogen peroxide than to expulsion of dissolved ozone.

The percentage of hydrogen peroxide as compared with the total weight of the air drawn over is 0·00038; that of nitric acid in the ozone wash-water only 0·00008. The former agrees quite closely with the result obtained in the previous experiment; the latter is about one-half.

Conclusion.—It will be noted that the chief by-product of the ozonisation of moist air by phosphorus, according to our determinations, is not phosphorous acid, but phosphoric acid. It is generally stated that the former of these two substances is the one principally produced under these circumstances. This may be true in the sense that the phosphorous acid is first formed, and that it gradually is transformed into phosphoric acid under the influence of nascent ozone. This point could not be very readily determined in the course of the experiments made with the apparatus described above.

It is certainly an error to ascribe, as is done in various

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[*] Note.—In Table I. the ammonia found in the ozone wash-waters by reduction is all calculated as HNO_3. If we, in like manner, convert the total ammonia contained in the air (see Table III.) into HNO_3, it will be found equal to 0·000088 per cent of the air drawn over; subtracting this from 0·0003 per cent, the amount given for P over H_2O in Table I., leaves 0·000212 per cent, and this, if regarded not as it was when the experiments were made, as HNO_3, but as NH_4NO_3, would give for the true percentage of HNO_3 in Table I., 0·000167 per cent.

text-books, the dense white fumes seen in the ozonising chambers, to ammonium nitrite—they are chiefly due to phosphoric anhydride.

The above experiments do not permit us to say that no ammonium nitrite was found during any period of the ozonation, they prove merely that no ammonium nitrite could be detected at its close. If, therefore, this body were produced, it must have become oxidised to ammonium nitrate.

As to the reason of the formation of ozone itself under these circumstances, it may be conjectured along with Lamont* and others, that it is connected with the uneven quantivalencies of the elements taking part in the reaction, which may be represented by the equation—

$$P_4+O_{14}=P_2O_3+P_2O_5+2O_3.$$

If this hypothesis be true, then we should anticipate the development of ozone whenever oxidation of a perissad occurred at temperatures compatible with the stability of the ozone molecule. Even at the temperature of combustion of hydrogen, this is supposed by C. Than† to be the case. He explains in this manner the presence of the ozone, which he states he has detected in the combustion of hydrogenous substances generally, and its absence in the combustion of carbon.

In entering into new combinations, the oxygen molecules must undergo temporary resolution into their constituent atoms. These, while *en route* to take up new positions in other combinations, and animated by their atomic energy, or energy of the nascent state, may either oxidise the oxygen molecule, or the nitrogen, or the molecule of water. In the first case, ozone would be produced; in the second, regarding water as the basic body and NNO as the nitryl, there might be formed, as Hunt has indicated, ammonium nitrate; in the third, hdyrogen peroxide.

It gives me much pleasure to acknowledge the co-operation of my assistant, Dr. Edgar Everhart, in the performance of these experiments.—*Journal of the American Chemical Society.*

NEW PROCESS FOR THE RAPID ESTIMATION OF PURE SUGAR IN RAW AND REFINED COMMERCIAL SUGARS.‡

By P. CASAMAJOR.

Part I.

The process for the estimation of sugar, which I propose to describe this evening, is based on a happy idea of M. Dumas. It cannot but be a matter of surprise that, although this idea was published several years ago, it has never been taken up and studied by the numerous chemists whose business it is to analyse sugar.

As an introduction to the subject, I will recall to your memories the main points relating to the process of M. Dumas, and, as this process was suggested to its eminent author, while studying that of Payen, we may also say a few words of the latter.

In 1846, Payen published a process for determining the amount of pure sugar in commercial sugars, which seems to conform more closely to the ordinary processes of chemical analysis than is the case with those which have been more generally adopted for testing sugars. This process consists in washing commercial sugars with alcohol previously saturated with pure sugar. The object of this operation was to wash out everything except the pure sugar, and this, after being freed from the sugar-saturated alcohol by washing with absolute alcohol, could be dried and weighed, as is done with other substances submitted to chemical analysis. Payen found, however, that the quantity of sugar obtained in this way was always less than the actual quantity present. He seems afterwards to have paid very little attention to this process, and apparently did not attach much importance to it.

It was reserved for Dr. Scheibler, of Berlin, in these latter years, to discover that the result obtained by the process of Payen was not the quantity of pure sugar present, but that it represents the *rendement*, or quantity of sugar obtainable in refining. It cannot but be a matter of surprise that Dr. Scheibler did not distinctly claim this discovery, instead of pretending that he had, in a manner, re-discovered the process of Payen, "which had fallen into the domain of history," when, indeed, he had only attached to it cumbersome paraphernalia, which really added nothing to the value of the process.

Payen used two alcoholic solutions saturated with sugar, and finally absolute alcohol, to wash out the last traces of the sugar-saturated solutions. The first solution was obtained by taking alcohol at 85 per cent, and adding to this 5 per cent of strong acetic acid. This mixture was saturated with sugar. I believe that this addition of 5 per cent of acetic acid was to decompose the sucrates, which were a great bugbear to the sugar chemists of those days. This addition of acetic acid fulfils, however, a useful purpose, as it seems to make the mixture better able to remove the impurities of gummy sugar.

This first solution of Payen was the one adopted by M. Dumas, and here is the process which he proposed for analysing commercial sugars:—

If we introduce an alcohometer of Gay-Lussac in the first solution of Payen, we find that it sinks to a point which, if we operate at 15° C., corresponds to 74 per cent. If we take a certain volume of this solution and stir it up in a glass with a sufficient quantity of a sugar to be analysed, we are able to ascertain, by again placing the alcohometer in the solution, that this has taken up something from the commercial sugar, for the alcohometer no longer indicates 74 per cent, but a lower degree, corresponding to a greater density. The process which M. Dumas proposed was this: Take 100 cubic centimetres of the first solution of Payen and 50 grammes of sugar, agitate the mixture in a glass, filter the solution, and observe the alcohometric degree corresponding to 15° C. For every percentage of sugar less than 100 you will find that the solution indicates 1 per cent less than 74.

A simpler way of stating the same thing is to note that the difference between 100 and 74 is 26, and, if the above proposition is correct, we can obtain the percentage of sugar by adding 26 to the alcohometric degree. Thus, if the alcohometer indicates 68, the percentage of sugar is $68+26=94$.

The only account I have seen of this process is in L'Abbé Moigno's *Saccharimétrie Physique, Chimique et Mélassimétrique*; this is translated in the *American Chemist* of February, 1871, p. 302. This description may also be found *verbatim* in a recent work of M. Maumené on sugar.

The account of the process of M. Dumas, as found in the above paper, states that, for sugars having 87 per cent or more of pure sugar, the results agree very closely with those of the saccharometer, even within 1-10th of 1 per cent. For sugars of lower grade, the results obtained were not satisfactory.

After making a great number of tests with the solution used by M. Dumas, I am in a position to state that it is not possible, even with sugars of high grade, to obtain results at all approaching those of the optical saccharometer, when we operate on such sugars as we have in this market. The sugars to which the process was applied in France may have been beet sugars of about the same grade and similar composition. With our cane sugars, both raw and refined, the differences between the results of the saccharometer and those of the alcohometer were sometimes as high as 3 or even 4 per cent for sugars above 87 per cent. As to beet sugars I regret to say that,

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* Chemical News, vol. xxviii., p. 236.

† *Journ. Chem. Soc.* [2], vol. ix., 1871, p. 483; *Journ. Prakt. Chem.* [2], i., 415.

‡ Read before the American Chemical Society, June 5, 1879.

since I undertook these researches, I have not been able to obtain any samples to form an idea of their behaviour with this process of M. Dumas.

At any rate, as nearly one-half of the raw sugars that come to this market stand below 87 per cent, there seemed to be little use in a process which was declared to be inapplicable to sugars of low grade. I found, however, after trying the process several times, that, although the results obtained were mostly unfavourable, it was impossible to dismiss it entirely, for, upon reflecting upon these results, I found that many questions arose which required to be solved, and, on their solution, I based the hope of modifying this process so as to apply it to the analysis of cane sugars of all grades.

In considering commercial sugars, with the view of applying to them the process of M. Dumas, there are several points which experience has shown to be worthy of attention. Several other points, which have taken a great deal of my time, were found to be of no importance whatever in the study of this question.

To understand the points that are of importance in this inquiry, we may consider that a commercial sugar is composed of four classes of substances:—

1st. Pure sugar.

2nd. Water.

3rd. Soluble impurities, or other soluble substances, besides pure sugar.

4th. Sand, earth and other insoluble substances.

We may now examine each class separately.

1st. The behaviour of pure sugar with the saturated alcoholic solution used by M. Dumas is easily understood. This solution, being incapable of disolving any further quantity of sugar, its density cannot be affected by the addition of pure sugar alone.

2nd. An addition of water lowers the alcoholic degree. When an excess of sugar is present, the alcohol, diluted with water, is able to dissolve an additional quantity of sugar, which still further increases its density. To ascertain the quantities of pure sugar which alcohol of various strengths will hold, I took several saturated solutions and introduced them in the tube of the saccharometer. The results of the observations thus obtained are given in Table No. 1. In the first column of this table is the percentage of alcohol before being saturated with sugar; in the second column is the indication of the alcohometer for the same alcohol, after this has been saturated; in the third column is the direct reading of the optical saccharometer (Ventzke's), when the saturated solution is placed in its tube. Finally, in a fourth column, I have placed the number of grammes of sugar in 100 c.c. of the saturated alcohol. The quantities in this fourth column are calculated from those in the third, by taking 0·26 gr. of sugar as corresponding to one degree of the saccharometer scale.

Table No. 1.

Degree of the Alcohometer before saturation.	Ditto after saturation.	Degree of the saccharometer.	Grms. of sugar in 100 c.c.
92·0	91·0	2·2	0·572
87·0	82·3	—	—
85·0	79·5	12·2	3·17
84·0	78·0	14·6	3·80
82·4	74·0	19·3	5·02
80·0	67·62	26·3	6·83
75·0	48·55	50·0	13·01
50·0	sp. gr. 1·14	192·0	49·9

We may notice, in the above table, that if we compare alcohol of 85 per cent with alcohol of 80 and 75 per cent, that a fall of 5 per cent from 85 to 80 answers to a difference of 11·88 per cent in the corresponding saturated solutions, while a fall of 5 per cent from 80 to 75 corresponds to a difference of 19·07 per cent in their saturated solutions.

These facts are of prime importance in this inquiry, and we will have occasion in the sequel to draw from them consequences worthy of attention.

3rd. *Soluble Impurities.*—To study the effect of soluble impurities on alcohol saturated with sugar, I prepared quite a large quantity of inverted sugar by heating with hydrochloric acid. The acid was afterwards thrown down as chloride of lead, and a small quantity of lead which remained in solution was precipitated with carbonate of soda, but not enough of this reagent was used to make the solution alkaline. This solution was evaporated over a water-bath, and the result was, on cooling, a very stiff gummy substance of light yellow colour. The presence of a slight excess of sodic chloride did not interfere with the usefulness of the product, as it merely acted as the representative of the soluble impurities of commercial sugar, and these always contain soluble salts.

The effect of dissolving inverted sugar in alcohol saturated with sugar was to lower the alcohometric degree, and this lowering was progressively greater as the quantity of inverted sugar was increased. Thus, 5 grms. of inverted sugar lowered the alcohometric degree 11·63 per cent, and 10 grms. lowered it 24·5 per cent, while, if the decrease had been strictly proportional to the quantity of inverted sugar, 10 grms. should have given 11 63 × 2 = 23·26 per cent. We may note, however, that the lowering of the alcoholic degree by inverted sugar, which here stands as the representative of the soluble impurities, although not exactly proportional to the quantity added, is more nearly so than is the case with equivalent quantities of water, as we may see in Table No. 1.

4th. *Insoluble Impurities.*—These have no effect whatever on the density of an alcoholic solution saturated with sugar. With clean, dry sand, as well as with pure, dry sugar, no effect takes place in the density of the alcoholic solution. When insoluble substances occur in appreciable quantities, they should be deducted from the indication of the alcohometer.

It must be understood that in the experiments which are related above with water and inverted sugar, an excess of pure, dry sugar was always present. Otherwise the results obtained would not have been applicable to the analysis of sugars.

Although four classes of substances have been mentioned as worthy of consideration, only water and the soluble impurities have any influence in the results obtained by the process of M. Dumas. If a certain weight of water lowered the alcohometric degree to exactly the same extent as an equal weight of soluble impurities, the process proposed by M. Dumas could, by taking a less weight of sugar for 100 c.c. of solution, be made to yield accurate results; but this does not happen, and if we have, for instance, a sugar containing 94 per cent of pure sugar, the other constituents may be either 6 per cent of water or 6 per cent of impurities, or any sum of impurities and water amounting altogether to 6 per cent. In each of these cases we may obtain a different result. On the other hand, as the addition of a certain quantity of water gives very different results, according to the strength of the alcohol solution, we can conceive that, by a series of experiments, we may succeed in obtaining a solution of such strength that, within the limits which correspond to commercial sugars, the results in lowering the alcoholic degree may be practically the same for a certain quantity of water as for the same quantity of soluble impurities.

Following up this idea, I made a great many experiments, to ascertain whether it was not possible, by raising or lowering the alcohometric degree of a saturated sugar solution, to obtain exactly the strength that would give the required result. In this connection, I may mention, that at an early stage of my experiments, I discarded the use of acetic acid, and I operated with mixtures of alcohol and water only. I found that the solution used by M. Dumas could be replaced by alcohol of 82·4 per cent, saturated with sugar. I tried other solutions, some stronger and others weaker, and I was not long in finding that the bad results obtained with either the solution of M. Dumas or with alcohol of 82·4, saturated with sugar were much aggravated when the solutions had less alcoholic strength. By a series of experiments, I finally came to the conclusion that a solution of 87 per cent alcohol would give the most satisfactory results. Alcohol of this strength, when saturated with sugar, stands at 82·3 by the alcohometer. This solution answered very well with sugars of quite high grade, but when I came to apply it to gummy sugars, the impurities would not dissolve, and the results obtained were always a great deal too high. I sought to remedy the evil by taking alcohol at 94 per cent, and lowering the degree with acetic acid instead of water, because, as I have said, acetic acid has a favourable action in dissolving gummy impurities, but I did not succeed in effecting this object, and, much to my disappointment, I had to give up, for a time at least, the project of applying the idea of M. Dumas to the analysis of cane sugars.

(To be continued.)

COMPOSITION AND QUALITY OF THE METROPOLITAN WATER.

July, 1879.

The following are the returns of the Society of Medical Officers of Health:—

	Appearance in 2 foot Tube.	Ammonia.		Nitrogen as Nitrates, &c.	Oxygen used to Oxidise Organic Matter.	Total Solids.	Lime.	Magnesia	Chlorine	Sulphuric Anhydride.	Hardness on Clark's Scale.	
		Saline. Grs.	Organic. Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Before Boiling. Degrees.	After Boiling.
Thames Water Companies.												
Grand Junction	Clear	0·000	0·011	0·105	0·139	21·74	8·500	0·514	1·080	1·16	14·2	3·0
West Middlesex	Clear	0·000	0·011	0·095	0·135	21·00	7·050	0·504	1·080	1·40	13·3	3·0
Southwark and Vauxhall	Clear	0·000	0·008	0·120	0·133	19·80	7·160	0·468	1·000	1·43	14·2	3·8
Chelsea	Clear	0·000	0·010	0·120	0·105	19·00	7·400	0·468	1·080	1·84	14·0	3·0
Lambeth	Clear	0·000	0·006	0·094	0·105	20·80	8·170	0·720	1·080	1·40	13·2	4·8
Other Companies.												
Kent	Clear	0·000	0·001	0·300	0·001	27·90	8·560	0·750	1·512	2·06	18·2	5·1
New River	Clear	0·000	0·003	0·135	0·056	19·80	7·530	0·470	1·080	1·43	14·0	4·0
East London	Clear	0·000	0·007	0·105	0·066	21·80	7·280	0·504	1·220	1·36	14·0	3·6

The quantities of the several constituents are stated in grains per imperial gallon.

Note.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

C. Meymott Tidy, M.B.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 6, 1879.

Sulphurea of Dimethyl-para-phenylen-diamin.—A. Baur.—This compound has the formula $C_{17}H_{22}N_4S$.

Action of Oxalic Ethyl-ether upon Dimethyl-para-phenylen-diamin.—R. Sendtner.—The compounds here examined are dimethyl-para-phenylen-diamin-oxamic ethyl-ether, a body of a basic nature, insoluble in water, and but sparingly soluble in ether and cold alcohol, and dimethyl-para-phenylen-diamin-oxamic acid, mono-para-amido-dimethyl-phenyl-oxamid, and the corresponding di substance.

Phenyl-glyceric Acid or Styceric Acid.—R. Anschütz and L. P. Kinnicutt.—An account of some of the salts of this acid, and of its transformation into dibenzoyl-phenyl-glyceric ethyl-ether.

Desoxalic Acid and its Decomposition into Tartronic Acid.—H. Brunner.—The author has ascertained that the formula of desoxalic acid is $C_6H_8O_9$, and that it forms salts with three or four equivalents of metal. He describes the action of ammonia upon the ether, and the formation of tartronic acid from non-crystalline desoxalic ether.

On Ytterbia.—L. F. Nilson.—The author considers that Marignac had good grounds for assuming that ytterbia is perfectly white, gives no absorption bands, and that its molecular weight =131. Nilson having taken up the investigation obtained, after thirteen successive decompositions, an earth of the remarkably low molecular weight 127·6, which he traced to the partial presence of erbia. He hopes to complete the proof that the atomic weight of ytterbia is 132, that it is quadrivalent, and forms a sesquioxide.

On Scandium, a New Earthy Metal.—L. F. Nilson.—Scandium, a metal separated from ytterbia but not as yet obtained in a state of absolute purity, is a white earth whose solutions give no absorption bands. After ignition it is attacked but slowly by dilute nitric acid, but more readily by hydrochloric. The solution of the nitrate is completely precipitated by oxalic acid. The nitrate is completely decomposed at a temperature at which ytterbium nitrate is only partially resolved into a basic salt. The atomic weight, calculated on ScO, must be below 90. The author doubts, however, this composition of the oxide, and thinks the formula ScO_2 more probable. Scandium would then rank between tin and thorium, and with an atomic weight of about 170 it would break the vacancy now intervening between 118 and 234.

Constituents of Combustible Gases in the Potash Mines at Stassfurt.—H. Precht.—In some parts of these mines a combustible gas is liberated in considerable quantities. If mixed with common air it becomes explosive and may give rise to serious accidents. Its composition is:—

Hydrogen	93·053 vols.
Methyl hydrogen	0·778 „
Nitrogen	5·804 „
Carbonic acid	0·180 „
Oxygen	0·185 „
Carbonic oxide	trace
	100·000 „

The author ascribes the origin of this large proportion of hydrogen to the oxidation of ferrous chloride in the absence of air. $6FeCl_2+3H_2O=2Fe_2Cl_6+FeO_3+6H$.

Measurements of the Density of Organic Solids.—H. Schrœder.—The following uniformities appear from the results:—The author shows that in the silver salts of the fatty acid series, and in the ether-sulpho salts of potassium and barium, that for every CH_2 in their composition the volume increases by 3 steres; and that the elements C, H, O, and N, in the solid state, generally occupy the volume of one stere.

Bernardinite, a Resinoid Mineral from San Bernardino, California.—J. M. Stillman.—The composition of this mineral is:—

Water	3·87
Carbon	64·46
Hydrogen (not as water)	8·75
Oxygen ,, ,, ...	22·80
Ash..	0·12
	100·00

Croton-aldehyd and its Homologues.—A. Lieben and S. Zeisel.—The authors have succeeded by the action of a solution of sodium acetate upon propion-aldehyd in obtaining a condensation product homologous to croton-aldehyd.

Sulphalizaric Acid.—C. Graebe.—The potassium and sodium salts of this acid are soluble in water; those of the alkaline earths and of lead insoluble or sparingly soluble. The salts in which one atom of hydrogen is replaced by a metal are orange or yellow, and if heated in a dry state they yield alizarin. The behaviour of the free acid is similar. Where two atoms of hydrogen are replaced no alizarin is produced, save in case of ammonia. The compounds of the alkalies are a reddish violet, and those of barium and calcium orange. Where three atoms are replaced the behaviour is similar; the salts are violet and are the most readily soluble.

Sulphin Compounds of the Thio-ureas.—A. Bernthsen and H. Klinger.—The authors have obtained a permanent base by the action of benzyl-chloride upon thiourea.

Purification of Mercury.—J. W. Brühl.—With reference to the method proposed (*Berichte*, xii., 437) by Lothar Meyer, the author states that he tried it some time ago, but with unsatisfactory results.

Derivatives of Cantharidin and their Relations to the Ortho Series.—J. Piccard.—From an examination of cantharen and cantharic acid the author concludes that the cantharidin derivatives are in the ortho series what the camphor derivatives are in the para series.

Fluor-benzol-sulphonic Acid and on Melting-points of Substituted Benzol-sulphon Compounds.—W. Lenz.—No regularities have been detected in the ortho series and the meta compounds have not been sufficiently studied. But as regards the amides and chlorides of the para series the melting-points rise with the increasing molecular weight. The author gives a caution against certain filter-papers containing lignin, which gave rise to perplexing colour reactions.

On α- and β-nitro-alizarin and β-amido-alizarin.—E. Schunck and H. Rœmer.—Not suitable for useful abstraction.

On Anthrol.—C. Liebermann and O. Hörmann.—A description of sodium anthracen monosulphate and the corresponding barium and lead salts; of anthrol, acetanthrol, anthrol-ethyl-ether, and acetyl-mono-oxy-anthraquinon.

Sulphuretted Dyes Obtained from Dimethyl-phenylen-diamin.—A. Koch.—The author has determined the composition of the blue and the red dyes obtained by the patented process of the Baden Aniline Company (No. 1886).

Diphenyl-sulpho-hydantoin.—A. Lange.—Not suitable for useful abstraction.

Dinitro-hydro-cinnamic Acid and its Derivatives.—S. Gabriel and J. Zimmermann.—Among the derivatives here described are the ethyl-ether, amido-nitro-hydro-cinnamic acid, dibrom-amido-hydro-carbo-styril, and the corresponding mono compound.

Sulphamin-mesitylenic Acids and the Second Oxy-mesitylenic Acid.—Oscar Jacobsen.—Not suitable for abstraction.

Mercuric Iodide.—H. Kœhler.—Mercuric iodide melts not, as stated in chemical text-books, at 238°, but between 253° to 254°, and forms, not an amber-yellow, but a blood-red liquid.

Determinations of the Vapour-densities of certain Inorganic Bodies.—V. and C. Meyer.—The vapour of phosphorus pentasulphide has the density 7·63 to 7·67, calculation showing 7·67. The vapour-density of indium chloride is 7·87, calculation giving 15·20 if In_2Cl_6, or 7·60 if $InCl_3$.

Vapour-densities of Aqueous Acids Boiling at Constant Temperatures.—A. Calm.—The author shows that the vapours of formic, of hydrobromic, and of hydrochloric acids are mixtures respectively of 3, 6, and 9 mols.

Paratoluylic and Terephthalic Acids.—H. Fischli.—An elaborate paper, not susceptible of useful abstraction.

Recognition of the Fatty Alcohols.—H. Gutknecht.—The boundary for the application of Meyer and Locher's test is reached in the secondary class with amyl iodide, whilst with primary alcohols it succeeds in the octylic series, and might probably extend still higher.

Constitution of Parabanic Acid.—A. Calm.—Parabanic acid may be regarded as an intermediate anhydride of oxalic acid and urea.

Benzoyl-cyanide and Phenyl-glyoxylic Acid.—L. Claissen.

Amides of Phenyl-glyoxylic Acid.—L. Claissen.—These two papers do not admit of useful abstraction.

Gas-analytical Determination of Hydrogen by Absorption.—W. Hempel.—This memoir requires the accompanying engraving.

Diphenyl-phthalid and Phenol-phthalein.—A. Baeyer.—The author shows that phenol-phthalein is a dioxy-substitution product of the so-called phthalophenon, which is not a keton, but a diphenyl-phthalide.

Phthal-alcohol.—J. Hessert.—This hydrocarbon is converted by potassic permanganate into phthalic acid, whilst the action of nitric acid yields merely phthalid.

Further Examination of the Putrescent Products of Albumen.—E. and H. Salkowski.—Among the products obtained are phenyl-propionic acid, phenyl-acetic acid, succinic acid, indol, skatol, and phenol, besides small quantities of bodies which require further investigation.

Behaviour of Phenyl-acetic and Phenyl-propionic Acids in the System.—E. and H. Salkowski.—Phenyl-propionic acid in the organism is completely transformed into benzoic acid, and finally appears as hippuric acid in the urine. Phenyl-acetic acid is not oxidised, but forms a corresponding hippuric acid, which might be most accurately named phenaceturic acid.

Dichloracrylic Acid from Muco-chloric Acid.—W. Z. Bennet and H. B. Hill.—A description of the former acid and of some of its salts.

Disubstituted Acrylic Acids.—H. B. Hill.—Not suitable for abstraction.

Synthesis of Oxy-ketons by the Introduction of Acid Radicles into Phenols.—O. Dœbner and W. Wolff.—An account of the formation and properties of dibenzo-hydro-quinon.

Chemiker Zeitung.
No. 30, July 24, 1879.

According to Dr. Lenden, the oxidising power of the foam of the waves of the North Sea, observed by Prestel, of Emden, is probably due to the presence of hydrogen peroxide.

Antiseptic power of Pyrogallic Acid.—Bovet has proved experimentally, that pyrogallic acid prevents alcoholic fermentation. and deodorises offensive matter, swarming with bacteria. Kolbe and Meyer, on the other hand, show that the antizymotic power of pyrogallic acid is trifling compared with that of salicylic acid.

Direct Determination of Silver in Galena on Volhard's Principle.—C. A. M. Balling.—From 2 to 5 grms. of the galena, according to its supposed richness in silver, are very finely ground and intimately mixed in a porcelain mortar with from 3 to 4 times its weight of a flux composed of equal parts of soda and saltpetre, placed in a porcelain crucible, covered, and heated over a burner to thorough fusion, when the mixture is well stirred with a glass rod. It is then let cool and placed in an evaporating dish partly filled with water, in which the melted matter is softened, dissolved out of the crucible into the dish, which is then heated, and the watery solution is filtered into a flask. The residue on the filter, after being well washed, is rinsed back into the dish, very dilute nitric acid is added, and the whole evaporated to dryness. The dry residue is taken up in water acidulated with nitric acid, heated, and filtered into the same flask in which is the aqueous solution. The residue is washed with hot water, the filtrate is allowed to cool in the flask, ferric sulphate or iron alum is added, and the liquid is titrated.—*Oest. Zeitschift Berg. u. Hütten.*

Reimann's Färber Zeitung,
No. 28, 1879.

It is said ahat the "vert acide" of Poirrier is a sulphacid of the base of the so-called malachite green.

Bindschedler and Busch, of Bâle, have introduced into commerce a crystalline violet dye, said to be the hydrochlorate of benzylated rosanilin.

Examination of Albumen.—Cordillot dissolves the dry samples in 40 parts of distilled water, and judges the solutions by their degree of fluidity and the presence or absence of insoluble matter. A fine precipitate capable of passing a strainer, is more to be dreaded than large insoluble particles. Equal measures of the solutions are poured into test-glasses, set in cold water, heated slowly to a boil, which heat is maintained for a quarter of an hour. The bulkier the coagulum the better is the quantity. Some samples do not yield a clot at all if dissolved in more than 15 parts of water. The author considers Russion blood-albumen as preferable to all others.

Moniteur Scientifique, Quesneville.
August, 1879.

Recent Progress of Chemical Industry, according to the Reports of Prof. Hofmann. —*Soda*, by M. Landolt.—This memoir, which occupies nearly half the issue, is a continuation of the reports on the progress of the chemical arts during the ten years previous to the Vienna Exhibition.

Condensation of Acid Vapours from Alkali Works.—Dr. Angus Smith.—Translated from an English source.

Reversion of Superphosphates.—H. Joulie.—Taken from the *Comptes Rendus.*

The so-called Catalytic Force.—Donato Tommasi,—The author considers that the combination of oxygen and hydrogen by means of platinum sponge may be explained on thermo-dynamical principles. Porous bodies, as is well known, condense a certain quantity of gases, variable according to circumstances. This condensation is attended with the liberation of heat. If its quantity is sufficient the gases absorbed enter into mutual reaction.

History of the Isomeric Purpurins.—Dr. H. Morton.—This paper has already appeared in the Chemical News.

Constitution of Ultramarine.—R. Rickmann.—Already noticed.

Impurities contained in Glacial Acetic Acid.—M. Bardy.—The actual acid present in the 57 specimens examined varied from 87 to 99·5 per cent. The author finds that the oil of turpentine may serve for determining with exactness the acid present. For this purpose he takes 10 c.c. of the sample, and carfully drops into it oil of turpentine from a burette graduated into tenths of a c.c. until the last drop added dissolves after slight agitation without producing a permanent turbidity. The quantity of oil which may thus be added increases with the quantity of pure acid. In samples above 99·5 per cent in strength the oil dissolves in any proportion. To obtain comparable results the samples operated upon should be at one and the same temperature, 15° being the most suitable.

In practice it is sufficient to add to a known volume of the acid eight to ten times its volume of the oil and to stir two or three times. If the mixture remains clear the strength of the acid is at least 97 to 98 per cent. Otherwise it should be rejected.

M. Antony Guyard announces a new work on the atomic theory and on his novel theory, to which he gives the name of "tomic."

Les Mondes, Revue Hebdomadaire des Sciences.
No. 13, July 24, 1879.

Treatment of Rabies.—It is recommended to brush the inside of the animal's mouth and tongue first with a liquid not named, then with alcohol at 86 per cent in which Caripagero resin had been dissolved, and lastly with a litre of water containing 100 grms. of liquid ammonia.

MISCELLANEOUS.

Mineralogical Society of Great Britain and Ireland.—The Fourth Annual General Meeting, to receive the Report of the Council, and elect Officers for the ensuing year, and for general business, will be held at the Freemasons' Hall, Surrey Street, Sheffield (by kind permission of the authorities), on Friday, August 22, 1879, at 3 p.m. The following papers will be read:—"On the Production of Different Secondary Forms of Crystalline Minerals," by H. C. Sorby, F.R.S.; "New Scottish Minerals," by Prof. M. F. Heddle; "On some Cornish Serpentinous Rocks," by J. H. Collins, F.G.S.

TO CORRESPONDENTS.

G. and F. Malthorp.—No simple means known.
Studio.—It is a legal question.

PATENTS.—Mr. Vaughan, F.C.S., British, Foreign, and Colonial PATENT AGENT. Special attention given to Inventions relating to Chemistry, Mining, and Metallurgy. "Guide to Inventors" Free by Post.—Offices, 67, Chancery Lane London, W.C. and 8, Houndgate Darlington.

WILLOUGHBY BROS., Central Foundry, Plymouth, Makers of Plant for Sulphuric Acid and Superphosphate Works, also for Tar and Ammonia Distilling.

NORRINGTON'S PATENT,

For the prevention of escape of gases during the charging of kilns and nitre pots. The success of this invention being assured, we are prepared to Contract for fixing this Patent Apparatus to Pyrites Furnaces throughout the Kingdom,

Estimates and Plans furnished on application.

THE CHEMICAL NEWS.

Vol. XL. No. 1030.

BRITISH ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE.

Sheffield Meeting, August 20, 1879.

INAUGURAL ADDRESS OF THE PRESIDENT,

Professor G. J. Allman,
M.D., LL.D., F.R.SS.L. and E., M.R.I.A., Pres. L.S.

It is no easy thing to find material suited to an occasion like the present. For, on the one hand, there is risk that a presidential address may be too special for an audience necessarily large and general, while, on the other hand, it may treat too much of generalities to take hold of the sympathies and command the attention of the hearers.

It may be supposed that my subject should have been suggested by the great manufacturing industries of the town which has brought us together, but I felt convinced that a worker in only the biological sciences could not do justice to the workers in so very different a field.

I am not therefore going to discourse to you of any of those great industries which make civilised society what it is,—of those practical applications of scientific truth which within the last half century have become developed with such marvellous rapidity, and which have already become interwoven with our everyday life, as the warp of the weaver is interwoven with the woof. Such subjects must be left to other occupiers of this chair, from whom they may receive that justice which I could not pretend to give them; and I believe I shall act most wisely by keeping to a field with which my own studies have been more directly connected.

I know that there are many here present from whom I have no right to expect that previous knowledge which would justify me in dispensing with such an amount of elementary treatment as can alone bring my subject intelligibly before them, and my fellow-members of the British Association who have the advantage of being no novices in that department of biology with which I propose to occupy you, will pardon me if I address myself mainly to those for whom the field of research on which we are about to enter has now been opened for the first time.

I have chosen, then, as the matter of my address to you to-night, a subject in whose study there has during the last few years prevailed an unwonted amount of activity, resulting in the discovery of many remarkable facts, and the justification of many significant generalisations. I propose, in short, to give you in as untechnical a form as possible some account of the most generalised expression of living matter, and of the results of the more recent researches into its nature and phenomena.

More than forty years have now passed away since the French naturalist Dujardin drew attention to the fact that the bodies of some of the lowest members of the animal kingdom consist of a structureless, semifluid, contractile substance, to which he gave the name of Sarcode. A similar substance occurring in the cells of plants was afterwards studied by Hugo von Mohl, and named by him Protoplasm. It remained for Max Schultze to demonstrate that the sarcode of animals and the protoplasm of plants were identical.

The conclusions of Max Schultze have been in all respects confirmed by subsequent research, and it has further been rendered certain that this same protoplasm lies at the base of all the phenomena of life, whether in the animal or the vegetable kingdom. Thus has arisen the most important and significant generalisation in the whole domain of biological science.

Within the last few years protoplasm has again been made a subject of special study, unexpected and often startling facts have been brought to light, and a voluminous literature has gathered round this new centre of research. I believe, therefore, that I cannot do better than call your attention to some of the more important results of these inquiries, and endeavour to give you some knowledge of the properties of protoplasm, and of the part it plays in the two great kingdoms of organic nature.

As has just been said, protoplasm lies at the base of every vital phenomenon. It is, as Huxley has well expressed it, "the physical basis of life." Wherever there is life, from its lowest to its highest manifestations, there is protoplasm; wherever there is protoplasm, there too is life. Thus co-extensive with the whole of organic nature—every vital act being referable to some mode or property of protoplasm—it becomes to the biologist what the ether is to the physicist; only that instead of being a hypothetical conception, accepted as a reality from its adequacy in the explanation of phenomena, it is a tangible and visible reality, which the chemist may analyse in his laboratory, the biologist scrutinise beneath his microscope and his dissecting needle.

The chemical composition of protoplasm is very complex, and has not been exactly determined. It may, however, be stated that protoplasm is essentially a combination of albuminoid bodies, and that its principal elements are, therefore, oxygen, carbon, hydrogen, and nitrogen. In its typical state it presents the condition of a semifluid substance—a tenacious, glairy liquid, with a consistence somewhat like that of the white of an unboiled egg.* While we watch it beneath the microscope movements are set up in it; waves traverse its surface, or it may be seen to flow away in streams, either broad and attaining but a slight distane from the main mass, or else stretching away far from their source, as narrow liquid threads, which may continue simple, or may divide into branches, each following its own independent course; or the streams may flow one into the other, as streamlets would flow into rivulets, and rivulets into rivers, and this not only where gravity would carry them, but in a direction diametrically opposed to gravitation; now we see it spreading itself out on all sides into a thin liquid stratum, and again drawing itself together within the narrow limits which had at first confined it, and all this without any obvious impulse from without which would send the ripples over its surface or set the streams flowing from its margin. Though it is certain that all these phenomena are in response to some stimulus exerted on it by the outer world, they are such as we never meet with in a simply physical fluid—they are spontaneous movements resulting from its proper irritability, from its essential constitution as living matter.

Examine it closer, bring to bear on it the highest powers of your microscope—you will probably find disseminated through it countless multitudes of exceedingly minute granules; but you may also find it absolutely homogeneous, and, whether containing granules or not, it is certain that you will find nothing to which the term *organisation* can be applied. You have before you a glairy, tenacious fluid, which, if not absolutely homogeneous, is yet totally destitute of structure.

And yet no one who contemplates this spontaneously moving matter can deny that it is alive. Liquid as it is,

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* In speaking of protoplasm as a liquid, it must be borne in mind that this expression refers only to its physical consistence—a condition depending mainly on the amount of water with which it is combined, and subject to considerable variation, from the solid form in which we find it in the dormant embryo of seeds, to the thin watery state in which it occurs in the leaves of Valisneria. Its distinguishing properties are totally different from those of a purely physical liquid, and are subject to an entirely different set of laws.

it is a living liquid; organless and structureless as it is, it manifests the essential phenomena of life.

The picture which I have thus endeavoured to trace for you in a few leading outlines is that of protoplasm in its most generalised aspect. Such generalisations, however, are in themselves unable to satisfy the conditions demanded by an exact scientific inquiry, and I propose now, before passing to the further consideration of the place and purport of protoplasm in nature, to bring before you some definite examples of protoplasm, such as are actually met with in the organic world.

A quantity of a peculiar slimy matter was dredged in the North Atlantic by the naturalists of the exploring ship *Porcupine* from a depth of from 5000 to 25,000 feet. It is described as exhibiting, when examined on the spot, spontaneous movements, and as being obviously endowed with life. Specimens of this, preserved in spirits, were examined by Prof. Huxley, and declared by him to consist of protoplasm, vast masses of which must thus in a living state extend over wide areas of sea bottom. To this wonderful slime Huxley gave the name of *Bathybius Haeckelii*.

Bathybius has since been subjected to an exhaustive examination by Prof. Haeckel, who believes that he is able to confirm in all points the conclusions of Huxley, and arrives at the conviction that the bottom of the open ocean, at depths below 5000 feet, is covered with an enormous mass of living protoplasm, which lingers there in the simplest and most primitive condition, having as yet acquired no definite form. He suggests that it may have originated by spontaneous generation, but leaves this question for future investigators to decide.

The reality of Bathybius, however, has not been universally accepted. In the more recent investigations of the *Challenger* the explorers have failed in their attempts to bring further evidence of the existence of masses of amorphous protoplasm spreading over the bed of the ocean. They have met with no trace of Bathybius in any of the regions explored by them, and they believe that they are justified in the conclusion that the matter found in the dredgings of the *Porcupine* and preserved in spirits for further examination was only an inorganic precipitate due to the action of the alcohol.

It is not easy to believe, however, that the very elaborate investigations of Huxley and Haeckel can be thus disposed of. These, moreover, have received strong confirmation from the still more recent observations of the Arctic voyager, Bessels, who was one of the explorers of of the ill-fated *Polaris*, and who states that he dredged from the Greenland seas masses of living undifferentiated protoplasm. Bessels assigns to these the name of Protobathybius, but they are apparently indistinguishable from the Bathybius of the *Porcupine*. Further arguments against the reality of Bathybius will therefore be needed before a doctrine founded on observations so carefully conducted shall be relegated to the region of confuted hypotheses.

Assuming, then, that Bathybius, however much its supposed wide distribution may have been limited by more recent researches, has a real existence, it presents us with a condition of living matter the most rudimental it is possible to conceive. No law of morphology has as yet exerted itself in this formless slime. Even the simplest individualisation is absent. We have a living mass, but we know not where to draw its boundary lines; it is living matter, but we can scarcely call it a living being.

The President made further allusion to the researches of Haeckel and others on protoplasm, passing to the consideration of the higher stages in the development of protoplasmic beings. On referring to the characteristic spectrum which the colouring matter of chlorophyll presents under the spectroscope, he said that for our knowledge of its optical properties we are mainly indebted to the elaborate investigations of Dr. Sorby, which have contributed largely to the advancement of an important department of physical science.

To the presence of chlorophyll is due one of the most striking aspects of external nature—the green colour of the vegetation which clothes the surface of the earth; and with its formation is introduced a function of fundamental importance in the economy of plants, for it is on the cells which contain this substance that devolves the faculty of decomposing carbonic acid. On this depends the assimilation of plants, a process which becomes manifest externally by the exhalation of oxygen. And it is under the influence of light on the chlorophyll-containing cells that this evolution of oxygen is brought about. The recent observations of Draper and of Pfeffer have shown that in this action the solar spectrum is not equally effective in all its parts; that the yellow and least refrangible rays are those which act with most intensity; that the violet and other highly refrangible rays of the visible spectrum take but a very subordinate part in assimilation; and that the invisible rays which lie beyond the violet are totally inoperative.

The President also referred to the fact that the action of chlorophyll in bringing about the decomposition of carbonic acid is not, as was recently believed, absolutely confined to plants. Green Hydra, and certain green planariæ and other worms, chlorophyll is differentiated in their protoplasm, and probably always acts here under the influence of light exactly as in plants.

It has, indeed, been proved by some recent researches of Mr. Geddes, that the green planarias when placed in water and exposed to the sunlight give out bubbles of gas which contain from 44 to 55 per cent of oxygen. Mr. Geddes has further shown that these animals contain granules of starch in their tissues, and in this fact we have another striking point of resemblance between them and plants.

A similar approximation of the two organic kingdoms has been shown by the beautiful researches of Mr. Darwin and others. Indeed, all recent research has been bringing out in a more and more decisive manner the fact that there is no dualism in life,—that the life of the animal and the life of the plant are, like their protoplasm, in all essential points identical.

But there is, perhaps, nothing which shows more strikingly the identity of the protoplasm in plants and animals, and the absence of any deep-pervading difference between the life of the animal and that of the plant, than the fact that plants may be placed, just like animals, under the influence of anæsthetics.

When the vapour of chloroform or of ether is inhaled by the human subject, it passes into the lungs, where it is absorbed by the blood, and thence carried by the circulation to all the tissues of the body. The first to be affected by it is the delicate nervous element of the brain, and loss of consciousness is the result. If the action of the anæsthetic be continued, all the other tissues are in their turn attacked by it and their irritability arrested. A set of phenomena entirely parallel to these may be presented by plants.

We owe to Claude Bernard a series of interesting and most instructive experiments on the action of ether and chloroform on plants. He exposed to the vapour of ether a healthy and vigorous sensitive plant, by confining it under a bell-glass into which he introduced a sponge filled with ether. At the end of half an hour the plant was in a state of anæsthesia, all its leaflets remained fully extended, but they showed no tendency to shrink when touched. It was then withdrawn from the influence of the ether, when it gradually recovered its irritability, and finally responded, as before, to the touch.

It is obvious that the irritability of the protoplasm was here arrested by the anæsthetic, so that the plant became unable to give a response to the action of an external stimulus.

It is not, however, the irritability of the protoplasm of only the motor elements of plants that anæsthetics are capable of arresting. These may act also on the protoplasm of those cells whose function lies in chemical synthesis, such as is manifested in the phenomena of the germination of the seed and in nutrition generally, and Claude Bernard has shown that germination is suspended by the action of ether or chloroform.

Seeds of cress, a plant whose germination is very rapid, were placed in conditions favourable to a speedy germination, and while thus placed were exposed to the vapour of ether. The germination, which would otherwise have shown itself by the next day, was arrested. For five or six days the seeds were kept under the influence of the ether, and showed during this time no disposition to germinate. They were not killed, however, they only slept, for on the substitution of common air for the etherised air with which they had been surrounded, germination at once set in and proceeded with activity.

Experiments were also made on that function of plants by which they absorb carbonic acid and exhale oxygen, and which, as we have already seen, is carried on through the agency of the green protoplasm or chlorophyll, under the influence of light—a function which is commonly, but erroneously, called the respiration of plants.

Aquatic plants afford the most convenient subjects for such experiments. If one of these be placed in a jar of water holding ether or chloroform in solution, and a bell-glass be placed over the submerged plant, we shall find that the plant no longer absorbs carbonic acid or emits oxygen. It remains, however, quite green and healthy. In order to awaken the plant, it is only necessary to place it in non-etherised water, when it will begin once more to absorb carbonic acid, and exhale oxygen under the influence of sunlight.

The same great physiologist has also investigated the action of anæsthetics on fermentation. It is well known that alcoholic fermentation is due to the presence of a minute fungus, the yeast fungus, the living protoplasm of whose cells has the property of separating solutions of sugar into alcohol, which remains in the liquid, and carbonic acid, which escapes into the air.

Now, if the yeast plant be placed along with sugar in etherised water it will no longer act as a ferment. It is anæsthesiated, and cannot respond to the stimulus which, under ordinary circumstances, it would find in the presence of the sugar. If, now, it be placed on a filter, and the ether washed completely away, it will, on restoration to a saccharine liquid, soon resume its duty of separating the sugar into alcohol and carbonic acid.

Claude Bernard has further called attention to a very significant fact which is observable in this experiment. While the proper alcoholic fermentation is entirely arrested by the etherisation of the yeast plant, there still goes on in the saccharine solution a curious chemical change, the cane sugar of the solution being converted into grape sugar, a substance identical in its chemical composition with the cane sugar, but different in its molecular constitution. Now it is well known from the researches of Berthelot that this conversion of cane sugar into grape sugar is due to a peculiar inversive ferment, which, while it accompanies the living yeast plant, is itself soluble and destitute of life. Indeed it has been shown that in its natural conditions the yeast fungus is unable of itself to assimilate cane sugar, and that in order that this may be brought into a state fitted for the nutrition of the fungus, it must be first digested and converted into grape sugar, exactly as happens in our own digestive organs. To quote Claude Bernard's graphic account:—

"The fungus ferment has thus beside it in the same yeast a sort of servant given by nature to effect this digestion. The servant is the unorganised inversive ferment. This ferment is soluble, and as it is not a plant, but an unorganised body destitute of sensibility, it has not gone to sleep under the action of the ether, and thus continues to fulfil its task."

In the experiment already recorded on the germination of seeds the interest is by no means confined to that which attaches itself to the arrest of the organising functions of the seed, those namely which manifest themselves in the development of the radicle and plumule and other organs of the young plant. Another phenomenon of great significance becomes at the same time apparent—the anæsthetic exerts no action on the concomitant chemical phenomena which in germinating seeds show themselves in the transformation of starch into sugar under the influence of diastase (a soluble and non-living ferment which also exists in the seed), and the absorption of oxygen with the exhalation of carbonic acid. These go on as usual, the anæsthesiated seed continuing to respire, as proved by the accumulation of carbonic acid in the surrounding air. The presence of the carbonic acid was rendered evident by placing in the same vessel with the seeds which were the object of the experiment a solution of barytes, when the carbonate became precipitated from the solution in quantity equal to that produced in a similar experiment with seeds germinating in unetherised air.

So, also, in the experiment which proves the faculty possessed by the chlorophyllian cells of absorbing carbonic acid and exhaling oxygen under the influence of light may be arrested by anæsthetics, it could be seen that the plant, while in a state of anæsthesia, continued to respire in the manner of animals; that is, it continued to absorb oxygen and exhale carbonic acid. This is the true respiratory function which was previously masked by the predominant function of assimilation, which devolves on the green cells of plants, and which manifests itself under the influence of light in the absorption of carbonic acid and the exhalation of oxygen.

It must not, however, be supposed that the respiration of plants is entirely independent of life. The conditions which bring the oxygen of the air and the combustible matter of the respiring plant into such relations as may allow them to act on one another are still under its control, and we must conclude that in Claude Bernard's experiment the anæsthesia had not been carried so far as to arrest such properties of the living tissues as are needed for this.

The quite recent researches of Schützenberger, who has investigated the process of respiration as it takes place in the cell of the yeast fungus, have shown that vitality is a factor in this process. He has shown that fresh yeast, placed in water, breathes like an aquatic animal, disengaging carbonic acid, and causing the oxygen contained in the water to disappear. That this phenomenon is a function of the living cell is proved by the fact that, if the yeast be first heated to 60° C. and then placed in the oxygenated water, the quantity of oxygen in the water remains unchanged; in other words, the yeast ceases to breathe.

Schützenberger has further shown that light exerts no influence on the respiration of the yeast cell—that the absorption of oxygen by the cell takes place in the dark exactly as in sunlight. On the other hand, the influence of temperature is well marked. Respiration is almost entirely arrested at temperatures below 10° C., it reaches its maximum at about 40° C., while at 60° C. it again ceases.

All this proves that the respiration of living beings is identical, whether manifested in the plant or in the animal. It is essentially a destructive phenomenon—as much so as the burning of a piece of charcoal in the open air, and, like it, is characterised by the disappearance of oxygen and the formation of carbonic acid.

One of the most valuable results of the recent careful application of the experimental method of research to the life phenomena of plants is thus the complete demolition of the supposed antagonism between respiration in plants and that in animals.

The President remarked that he had endeavoured to give in a few broad outlines a sketch of the nature and properties of one special modification of matter, which will yield to none other in the interest which attaches to its study, and in the importance of the part allocated to it in the economy of nature. Had occasion permitted he might have entered into many details which he had left untouched; but enough had been said to demonstrate that in protoplasm we find the only form of matter in which life can manifest itself; and that, though the outer conditions of life—heat, air, water, food,—may all be present, protoplasm would still be needed, in order that these conditions may be utilised, in order that the energy of lifeless nature may be converted into that of the countless multitudes of animal and vegetable forms which dwell upon the surface of the earth or people the great depths of its seas.

We are thus led to the conception of an essential unity in the two great kingdoms of organic Nature—a structural unity, in the fact that every living being has protoplasm as the essential matter of every living element of its structure; and a physiological unity, in the universal attribute of irritability which has its seat in this same protoplasm, and is the prime mover of every phenomenon of life.

We have seen how little mere form has to do with the essential properties of protoplasm. This may shape itself into cells, and the cells may combine into organs in ever-increasing complexity, and protoplasm force may thus be intensified, and, by the mechanism of organisation, turned to the best possible account; but we must still go back to protoplasm as a naked formless plasma if we would find—freed from all non-essential complications—the agent to which has been assigned the duty of building up structure and of transforming the energy of lifeless matter into that of living.

To suppose, however, that all protoplasm is identical where no difference cognisable by any means at our disposal can be detected would be an error. Of two particles of protoplasm, between which we may defy all the power of the microscope, all the resources of the laboratory, to detect a difference, one can develop only to a jelly-fish, the other only to a man, and one conclusion alone is here possible—that deep within them there must be a fundamental difference which thus determines their inevitable destiny, but of which we know nothing, and can assert nothing beyond the statement that it must depend on their hidden molecular constitution.

In the molecular condition of protoplasm there is probably as much complexity as in the disposition of organs in the most highly differentiated organisms; and between two masses of protoplasm indistinguishable from one another there may be as much molecular difference as there is between the form and arrangement of organs in the most widely separated animals or plants.

Herein lies the many-sidedness of protoplasm; herein lies its significance as the basis of all morphological expression, as the agent of all physiological work, while in all this there must be an adaptiveness to purpose as great as any claimed for the most complicated organism.

From the facts which have been now brought to your notice there is but one legitimate conclusion—that life is a property of protoplasm. In this assertion there is nothing that need startle us, The essential phenomena of living beings are not so widely separated from the phenomena of lifeless matter as to render it impossible to recognise an analogy between them; for even irritability, the one grand character of all living beings, is not more difficult to be conceived of as a property of matter than the physical phenomena of radial energy.

It is quite true that between lifeless and living matter there is a vast difference, a difference greater far than any which can be found between the most diverse manifestations of lifeless matter. Though the refined synthesis of modern chemistry may have succeeded in forming a few principles which until lately had been deemed the proper product of vitality, the fact still remains that no one has ever yet built up one particle of living matter out of lifeless elements—that every living creature, from the simplest dweller on the confines of organisation up to the highest and most complex organism, has its origin in pre-existent living matter—that the protoplasm of to-day is but the continuation of the protoplasm of other ages, handed down to us through periods of indefinable and indeterminable time.

Yet with all this, vast as the differences may be, there is nothing which precludes a comparison of the properties of living matter with those of lifeless.

When, however, we say that life is a property of protoplasm, we assert as much as we are justified in doing. Here we stand upon the boundary between life in its proper conception, as a group of phenomena having irritability as their common bond, and that other and higher group of phenomena which we designate as consciousness or thought, and which, however intimately connected with those of life, are yet essentially distinct from them.

When the heart of a recently killed frog is separated from its body and touched with the point of a needle, it begins to beat under the excitation of the stimulus, and we believe ourselves justified in referring the contraction of the cardiac fibres to the irritability of their protoplasm as its proper cause. We see in it a remarkable phenomenon, but one nevertheless in which we can see unmistakable analogies with phenomena purely physical. There is no greater difficulty in conceiving of contractility as a property of protoplasm than there is in conceiving of attraction as a property of the magnet.

When a thought passes through the mind it is associated, as we have now abundant reason for believing, with some change in the protoplasm of the cerebral cells. Are we therefore justified in regarding thought as a property of the protoplasm of these cells, in the sense in which we regard muscular contraction as a property of the protoplasm of muscle? or is it really a property residing in something far different, but which may yet need for its manifestation the activity of cerebral protoplasm?

If we could see any analogy between thought and any one of the admitted phenomena of matter, we should be bound to accept the first of these conclusions as the simplest, and as affording a hypothesis most in accordance with the comprehensiveness of natural laws; but between thought and the physical phenomena of matter there is not only no analogy, but there is no conceivable analogy: and the obvious and continuous path which we have hitherto followed up in our reasonings from the phenomena of lifeless matter through those of living matter here comes suddenly to an end. The chasm between unconscious life and thought is deep and impassable, and no transitional phenomena can be found by which as by a bridge we may span it over; for even from irritability, to which, on a superficial view, consciousness may seem related, it is as absolutely distinct as it is from any of the ordinary phenomena of matter.

It has been argued that because physiological activity must be a property of every living cell, psychical activity must be equally so, and the language of the metaphysician has been carried into biology, and the "cell soul" spoken of as a conception inseparable from that of life.

That psychical phenomena, however, characterised as they essentially are by consciousness, are not necessarily co-extensive with those of life, there cannot be a doubt. How far back in the scale of life consciousness may exist we have as yet no means of determining, nor is it necessary for our argument that we should. Certain it is that many things, to all appearance the result of volition, are capable of being explained as absolutely unconscious acts; and when the swimming swarm-spore of an Alga avoids collision, and by a reversal of the stroke of its cilia backs from an obstacle lying in its course, there is almost certainly in all this nothing but a purely unconscious act. It is but a case in which we find expressed the great law of the adaptation of living beings to the conditions which surround them. The irritability of the protoplasm of the ciliated spore responding to an external stimulus sets in motion a mechanism derived by inheritance from its ancestors, and whose parts are correlated to a common end —the preservation of the individual.

But even admitting that every living cell were a conscious and thinking being, are we therefore justified in asserting that its consciousness, like its irritability, is a property of the matter of which it is composed? The sole argument on which this view is made to rest is that from analogy. It is argued that because the life phenomena, which are invariably found in the cell, must be regarded as a property of the cell, the phenomena of consciousness by which they are accompanied must be also so regarded. The weak point in the argument is the absence of all analogy between the things compared, and as the conclusion rests solely on the argument from analogy the two must fall to the ground together.

In a lecture* to which I once had the pleasure of listening—a lecture characterised no less by lucid exposition than by the fascinating form in which its facts were presented to the hearers, Professor Huxley argues that no difference, however great, between the phenomena of living matter and those of the lifeless elements of which this matter is composed should militate against our attributing to protoplasm the phenomena of life as properties essentially inherent in it; since we know that the result of a chemical combination of physical elements may exhibit physical properties totally different from those of the elements combined; the physical phenomena presented by water, for example, having no resemblance to those of its combining elements oxygen and hydrogen.

I believe that Professor Huxley intended to apply this argument only to the phenomena of life in the stricter sense of the word. As such it is conclusive. But if it be pushed further, and extended to the phenomena of consciousness, it loses all its force. The analogy, perfectly valid in the former case, here fails. The properties of the chemical compound are like those of its components, still physical properties. They come within the wide category of the universally accepted properties of matter, while those of consciousness belong to a category absolutely distinct—one which presents not a trace of a connection with any of those which physicists have agreed in assigning to matter as its proper characteristics. The argument thus breaks down, for its force depends on analogy alone; and here all analogy vanishes.

That consciousness is never manifested except in the presence of cerebral matter, or of something like it, there cannot be a question; but this is a very different thing from its being a property of such matter in the sense in which polarity is a property of the magnet, or irritability of protoplasm. The generation of the rays which lie invisible beyond the violet in the spectrum of the sun cannot be regarded as a property of the medium which by changing their refrangibility can alone render them apparent.

I know that there is a special charm in those broad generalisations which would refer many very different phenomena to a common source. But in this very charm there is undoubtedly a danger, and we must be all the more careful lest it should exert an influence in arresting the progress of truth, just as at an earlier period traditional beliefs exerted an authority from which the mind but slowly and with difficulty succeeded in emancipating itself.

But have we, it may be asked, made in all this one step forward towards an explanation of the phenomena of consciousness or the discovery of its source? Assuredly not. The power of conceiving of a substance different from that of matter is still beyond the limits of human intelligence, and the physical or objective conditions which are the concomitants of thought are the only ones of which it is possible to know anything, and the only ones whose study is of value.

We are not, however, on that account forced to the conclusion that there is nothing in the universe but matter and force. The simplest physical law is absolutely inconceivable by the highest of the brutes, and no one would be justified in assuming that man had already attained the limit of his powers. Whatever may be that mysterious bond which connects organisation with psychical endowments, the one grand fact—a fact of inestimable importance—stands out clear and freed from all obscurity and doubt, that from the first dawn of intelligence there is with every advance in organisation a corresponding advance in mind. Mind as well as body is thus travelling onwards through higher and still higher phases; the great law of Evolution is shaping the destiny of our race; and though now we may at most but indicate some weak point in the generalisation which would refer consciousness as well as life to a common material source, who can say that in the far-off future there may not yet be evolved other and higher faculties from which light may stream in upon the darkness, and reveal to man the great mystery of Thought?

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION

BY

G. JOHNSTONE STONEY, M.A., F.R.S., Secretary to the Queen's University in Ireland,
President of the Section.

In order that we may understand the present position of Natural Science upon the Earth, we must remember that the universe is in itself one great whole, which includes minds no less than bodies, for thought is as much a phenomenon of what really exists as motion. But though the universe be but one, man with his limited powers is unable to treat it as such, but has to push his investigation of Nature when and where he can. Thus have arisen many sciences which were at first quite isolated. Their separate condition is a mark of the feebleness of our powers of investigation. Their gradual convergence, and especially where any complete contact can be established between them, is the mark that our advancing knowledge is penetrating deeper.

That there are many sciences of Nature, instead of one science of Nature, has its relation, then, to human imperfection. But the coalescence of sciences has commenced, and is steadily taking place; magnetism is no longer isolated from electricity, nor light from heat, nor the power of thinking from the condition of the brain. In all such cases we have got nearer to understanding what is really going on in Nature. There are already many such achievements of science; but, nevertheless, it remains true that human powers of investigation are so narrow, and the use we have made of them up to the present is so short of what we may reasonably look for in the future, that the sciences of Nature are still many, and most of them stand lamentably aloof from one another.

We find, then, in the present passing condition of our knowledge, one group of sciences which investigate the phenomena of consciousness; another distinct group of the biological sciences; and a third, the group of the physical sciences. These are all but parts of the one great investigation of Nature, but for the present they exist almost disconnected, as separate provinces of human inquiry.

When we endeavour to investigate mental phenomena, we are encountered by the complexity and remoteness of the effects which present themselves for examination, and by a deep and unpenetrated obscurity hanging over the interval between them and their causes. In order to make any progress even in the subordinate task of tracing out the relations of these effects to one another, the inquirer finds it necessary to venture upon hypothesis, and in all metaphysical speculation we sadly miss that healthy discipline with which Nature in other branches of science relentlessly refutes our hypotheses if they are wrong. Here, then, is a region in which the plausible may be mistaken for the true; and it is unfortunately certain that it

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* "The Physical Basis of Life." See *Essays and Reviews*, by T. H. Huxley.

has sometimes been so mistaken by the ablest human minds.

The biological sciences treat of all the phenomena of living beings except their mental phenomena, which are those which lie most remote from their causes. Here the complication is less, but it is still too great for the human mind to have yet penetrated behind it. We are still occupied with phenomena which lie at a great distance from their real causes. We are accordingly still far beyond the range of the exact sciences. Most of the great discoveries of biological science have been made by estimating the *general drift* of what is taught by a vast number of particular facts. This, it will be observed, is a kind of reasoning that is necessarily more or less inexact, and, as a consequence, it is one which requires wide intellectual training and great experience and tact to handle it with safety. When the investigator has brought these qualifications to his task, astonishing progress has been made in these sciences: without them the reasoning may degrade into being either trivial or loose.

In the rest of the study of Nature we are not embarrassed by the phenomena of life, and many mysteries therefore stand aside out of our path. Here lies the domain of the physical sciences. It is here that the mind of man has best been able to cope with the realities of the universe, and in which its greatest achievements have been effected. It is here that exact reasoning finds a predominant place.

The study of the physical sciences has been remitted by the British Association to its first two sections, chemistry being assigned to Section B, and the rest of the physical sciences to Section A. Accordingly, Section A includes the whole range of mathematics, along with the study of the conditions of rest and motion in that part of matter which is endowed with mass, and of the phenomena of sound, heat, light, and electricity, with the applications of these abstract studies in molecular physics and to astronomy, crystallography, and meteorology.

In meteorology, owing to the complication of the materials that have to be dealt with, we must have frequent recourse to the same kind of reasoning as has been found so effectual in the biological sciences; but in the other physical sciences which I have enumerated exact reasoning prevails, and on this account they are frequently classed together as the exact sciences.

The process of investigation in the exact sciences is fundamentally one in all cases. It has been well described by Mill in the third book of his "Logic." Nevertheless, it is notorious that minds which are well fitted for some branches of physical inquiry find difficulty—sometimes insuperable difficulty—in pursuing others. It is not every eminent mathematician who would have made an equally good chemist, or *vice versa*. This is because there exists a practical distinction separating the investigation of exact science into two well-marked classes when they are viewed, not as they are in themselves, but in their relation to the powers of us human beings. I refer to the distinction between the experimental method or the method of observation on the one hand, and the deductive method, or the method of reasoning on the other. All valid investigations in exact science appeal to what can be directly perceived, and all lead to a conclusion which can be reasoned out from it; but there are some of these investigations in which the main difficulty consists in making the appeal to the senses, and there are others in which the main difficulty lies in the process of reasoning.

To contend with these difficulties successfully requires very different qualities of mind and body. In experimental science the powers principally called into requisition are readiness and closeness of observation, dexterity in manipulation, skill in devising expedients, accuracy in making adjustments, and great patience. It also requires that the investigator should have an accurate memory of what else he has witnessed resembling the phenomenon under observation, that he should be quick to detect every point of agreement and difference that can be perceived, and be skilful to select those which are significant, and to employ them as materials for provision to guide his further proceedings. But the strain on the reasoning powers is generally less, often of trifling amount. The question is put to Nature, and it is Nature usually that gives the bulk of the answer. The most striking monument of splendid achievements by the experimental method of investigation unaided by the deductive method is to be found in the science of chemistry.

An equally typical instance of the power of the deductive method is the science of mechanics. This science, which has sunk deeper into the secrets of Nature than any other science, and which is the science towards whom all other physical sciences are at present more or less gravitating, is essentially deductive. There is little or no difficulty about its fundamental data. They are facts of Nature so patent to all men, and so indelibly implanted in human conception, that some persons have supposed that we have an intuitive perception of them. But, while the materials from which the mind is to work are thus easily obtained, it has taxed to the utmost the reasoning powers of understandings like Newton's to evolve the few consequences of them which are already known, and the investigator has to call to his assistance every aid to prolonged consecutive thought which mathematicians can devise.

In grappling with the problems of Nature we are seldom allowed the choice of the method of investigation we shall employ. This is commonly settled for us and not by us. Where we cannot advance without further information we must make further observations, *i.e.*, we must employ the experimental method, the appeal *ad experientiam:* where we cannot advance without understanding better what the information we possess really amounts to, we must employ the deductive method.

No reach of intellect applied to the materials in existence before 1860 could have elicited the fact that iron exists upon the sun. This great discovery was made by Professor Kirchhoff, a scientific man who was equally versed in both methods of investigation. On the present occasion it was the experimental method he employed. He applied to the scrutiny of the sun's spectrum four prisms of the most homogeneous glass that could be procured, figured with the greatest accuracy that the eminent artist Steinheil could attain. He expended far more pains on their adjustment for each successive part of the spectrum than any of his predecessors had done, and he was rewarded by a more perfect vision of the sun's glorious spectrum than had met the human eye before. In a collateral inquiry, suggested by an observation made by Foucault, he and Bunsen placed a metallic vapour emitting bright rays in front of a still brighter incandescent body, so that the light from the brighter background had to pass through this vapour, and they found that this vapour now caused dark lines in the spectrum occupying the positions which its own bright lines had before filled. Professor Kirchhoff thereupon added an appliance to his spectroscope which enabled him to bring a metallic spectrum and the solar spectrum together into the field of view, alongside of one another. On accomplishing this he saw sixty of the brightest of the iron rays as continuations of sixty of the strongest of the dark lines in the sun's spectrum; and, by an elaborate scrutiny, he satisfied himself that the observations had been pushed to a sufficient degree of exactness to make sure that a deviation would have been detected in any one of these sixty cases if it had amounted to as much as one-fourth of the average interval between consecutive lines of the solar spectrum. From this it was obvious that the sixty coincidences are not due to chance, but indicate that there is really iron vapour in the path of the rays. It will be observed that Kirchhoff's great merit and the real difficulty of his work lay in the scientific foresight and the industry which were required to frame hypotheses that were worth testing, to guide the investigation by these hypotheses, to contrive, construct, and adjust adequate apparatus, and to make with it the elaborate observations and the exact observations and maps which were necessary.

But when by these means the new facts had been brought to light, the inference from them that there is iron in the atmosphere of the sun was an easy one. This example will better convey than a definition what are the characteristic features of an experimental inquiry.

On the other hand, no series of observations or experiments, however skilfully arranged, could have enabled anyone to understand the cause of that familiar but truly surprising phenomenon that a top stands upon its peg while it is spinning. But a full explanation of it is within the reach of any student who will train his mind to reason consecutively, and avail himself of the aids to prolonged consecutive thought which mathematicians have contrived. He will then see that the most obvious and familiar mechanical facts involve as necessary consequences all the phenomena which he finds in the schoolboy's top, in the physicist's gyroscope, and in the precision and nutation of the heavens. This, then, is a problem of Nature which falls within the province of the deductive method.

Wherever data are known exactly, these inferences from these data, however remote, may be depended upon as corresponding with what actually occurs in Nature. And if in such cases the mind of man has proved equal to the task of drawing inferences which can effectually grapple with the problems he finds around him in the Universe—which is, alas! as yet but too seldom—then will the deductive method, our plummet, explore depths in the great ocean of existence which our anchors of experiment could not have reached.

The distinction which is here made between deductive and experimental investigations would have no place in a logical system. But it has direct reference to human convenience, and derives its importance from this circumstance. It is obvious, too, that an investigation may partake of both characters—that it may require all the powers of the scientific observer to get at the facts, or even to appreciate them, and all the resources of the mathematician to elicit the consequence of them. For instance, on beginning his electrical studies, the student of Nature must master a mixed experimental and deductive inquiry to get at the elementary fact that free electricity resides either at or outside the surfaces of conductors; and he must engage in a further inquiry, and one only within the reach of a trained mind, to deduce from this the law of the inverse square. And, again, no full appreciation or even intelligent use of the common electrostatic and electrodynamic measures which he meets at the threshold of his electrical studies is within the reach of the mere experimentalist or the mere theorist. And if this treacherous ground lies before the immature student at his entrance, what shall we say of the bogs he struggles into as he advances? We are perpetually meeting with inquiries of this mixed character in electricity and some of the other physical sciences, but they are comparatively rare in either medicines or chemistry, and none that is difficult lies in the path of the beginner. How many students are there who are made to slur over the above and a multitude of similar difficulties, and who are told that they are learning science, when in fact what they are really learning is the pernicious habit of being content to see Nature through a fog or through other men's mental eyes.

In mechanics valuable progress can be made by the mere mathematician, the student of deductive science; and in chemistry similar progress can be made by the mere experimentalist. Of all the physical sciences these are the most purely deductive, and the most purely experimental. What I desire particularly to invite attention to is that the two great methods of investigation may best be acquired in these two sciences, and that for a really sound grasp of the remaining physical sciences, and especially with a view to further advance in physical science, a command of both methods of investigation is essential.

We must bear in mind, too, that either method of investigation may be misapplied, and that this is a risk carefully to be guarded against. The deductive method when misapplied lands us in speculation; the experimental method becomes empiricism; and it so happens that the sciences of mechanics and chemistry are not only monuments of the power of the two great methods of investigation, but instructive examples of their weakness also. For in chemistry scarce any attempt at prolonged reasoning, carrying us by any lengthened flight to a distance from the experiments, can be relied on. The result has seldom risen to anything better than speculation. And on the other hand, in mechanics, conclusions which depend on experiments only are empirical; that is, they are deficient in accuracy, and their relation to the other phenomena of the science is left in darkness. Here, then, we find in these two sciences not only how strong these two methods of investigation are, but how weak they may become if misapplied.

I do not know whether any of my predecessors in this chair has experienced so much difficulty, or has hesitated so long and so much as I have hesitated in selecting the topic to which he would ask your attention. My first effort was an attempt to delineate the great recent progress of the mathematical and physical sciences, but it was unsatisfactory, partly from my own too scanty powers, and also because the variety, and even disparity, of the numerous sciences somewhat arbitrarily grouped together in Section A gave to the outline too sketchy a character. My next attempt was to make a selection among them, confining myself to those with which I am best acquainted, and endeavouring to direct attention to the problems which at the present time seem most to stand in need of solution. But here I felt unwilling either to bring forward or to withhold views which might be disputed. I then applied myself to the single consideration of what I hoped might prove useful and not inopportune at a time when one university, which I trust will prove a great university, is rising in the north of England, and when another university which has carefully and successfully fostered a high standard of education for thirty years, and which has thereby deserved and won the respect of educated men, has just been sacrificed to ecclesiasticism in the sister isle. In this university I have held the most central office for twenty-two years, and in the discharge of my duty had largely to influence its destiny in respect to almost every educational problem. Parliament in its wisdom has now seen fit to destroy this work, and I have not been without hope that from the experience which has been gained some effect which shall last may yet arise, and that the Queen's University may perhaps at its death bequeath a useful legacy to the University of Victoria. The advancement of Science in the North of England will largely depend for many years on the wisdom of the regulations for scientific training which are adopted at first by the new university; and I have therefore ventured, at this peculiar juncture, to submit to the judgment of my scientific brethren the principles which much thought and many trials extending over several years have led me to believe should guide them in selecting this part of a curriculum.

I have sought to show that it is in the study of mechanics and in the practice of chemistry that the two great methods of investigation may best be acquired. In them they may be studied separately, by steps of graduated difficulty, and with a superabundance of materials; and each of them supplies the necessary cautions with respect to the method which is all powerful in the other. No scientific man is really equipped for the pursuits in which both methods have to be employed till he has separately acquired a grasp of each. For it is only then that he will be armed against the errors which lead so many to mistake empiricism on the one hand, and speculation on the other, for solid science, or to underrate solid science, mistaking it for speculation. Nor is it only in his scientific occupations that he will derive benefit from this training. All exact reasoning, whether in science or in common life, belongs to these great divisions; and in the numberless instances in which we must be satisfied with reasoning which falls short of being exact, our only safety lies in having by the practice of exact reasoning, both deductive and experimental, attained to that intellectual tact and caution which alone will enable us to handle with safety the sharp and slippery tool. It is thus that a sound judgment with regard to truth may best be acquired by man or woman; and soundness of judgment is the noblest endowment of man's understanding, just as veracity is first among his virtues.

NOTE ON CHARACINE.

By Dr. T. L. PHIPSON, F.C.S., &c.

Among the organic substances present in fresh water is a new and interesting product, to which I have given the name Characine, for reasons that will appear presently. It is the substance to which Algæ in general—such as Confervæ, Oscillariæ, Desmids, &c., and the plants of the genus *Chara*—owe their peculiar odour, and communicate this odour to the water in which they abound.

I have obtained it, in minute quantities only at present, from *Palmella cruenta*, from *Vaucheria terrestris*, and from several Oscillariæ (*Oscillaria autumnalis*, *O. tenuis*, &c.) It is, apparently, more developed in the genus *Chara*, and *C. fœtida* will, I believe, yield it in larger quantity than the plants already mentioned. It is also plentifully produced by the dark coloured Oscillariæ growing on damp walls and by *Nostocs*.

Characine is a kind of camphor which gives to these plants, and to the waters in which they grow, that peculiar, highly characteristic, marshy odour, which is usually ascribed to products of their decomposition, but which is due entirely to the substance here described, produced by the plant in life and health. It is formed not only in those algæ which live entirely in water, but also by those, such as *Palmella* and *Oscillaria*, which flourish in moist places, and are occasionally subjected to desiccation. It is sometimes seen floating in extremely thin films upon the surface of stagnant waters and on that of tanks in which Algæ are cultivated. I obtained it first from *Palmella cruenta* whilst studying its curious pink colouring-matter, Palmelline, recently described in a note to the Paris Academy (of which remarkable substance I shall soon have more to say).

When a certain quantity of alcohol in which this plant has steeped for some twenty-four hours in a closed tube is diluted with fifteen to twenty times its volume of water, and then (the grains of chlorophyll having been allowed to deposit and the liquid decanted) shaken up with ether, the latter dissolves the characine, and leaves it on evaporation as a white greasy substance, having a strong and characteristic marshy odour; non-saponifiable by potash; lighter than water; gradually volatilising into the air (or disappearing by oxidation) from the surface of water on which it floats, and which thus loses its odour entirely in two or three days; soluble in alcohol and in ether, but nearly insoluble in water. (When heated with water in a closed tube it was transformed into a substance similar to vegetable wax, melting at 83° C., and having the odour of that substance; but this effect might have been due to some impurity). A better method of obtaining characine in a pure state is not to employ alcohol, but to operate as follows:—

The *Palmella* or *Oscillaria* which is to be treated must be previously dried by exposure to the air, at a temperature not exceeding summer heat, for about twenty-four hours. The "dry" substance is then covered with cold water in a capsule, which must itself be covered with a sheet of glass, and in the course of about thirty-six hours more (with *Palmella cruenta*) thin films of characine will be observed floating on the water. The latter is then decanted off into a long tube, together with the films (which are apt to stay behind in the capsule), and shaken up with ether as before mentioned. In this case the product is perfectly white, quite devoid of crystallisation, more or less unctuous in appearance, whilst that obtained by the use of alcohol has often a yellowish tint, and is probably impure. Up to the present time I have not obtained it in sufficient quantity to ascertain more of its properties.

BLEACHING OF SUGAR SYRUPS BY OZONE.

By ALBERT R. LEEDS.

Not being able to find in chemical journals any accounts of experiments upon coloured syrups with ozone as a bleaching agent, while there were rumours that many such had been tried, it appeared the readiest way of obtaining information to institute suitable trials, with quantitative determinations of the amounts of ozone employed and of the degrees of change effected.

The material was kindly furnished by Dr. Arne Behr, from syrups manufactured in the refinery of Messrs. Matthieson and Weichers, Jersey City. The first specimen was of syrup which had undergone but one filtration, and was of a brownish yellow colour. In this preliminary experiment the amount of ozone required to effect the bleaching was not determined. At its close, the syrup was of a faint straw colour and of slightly acid reaction.

A second trial was made upon a syrup which had been twice filtered, still retaining a strong yellow tint. 20 c.c. of the syrup were introduced into a Geissler absorption apparatus, and a slow current of oxygen, ozonised to the extent of 24 m.grms. ozone per litre, passed through it for several hours. When about 100 m.grms. ozone had been brought into contact with the syrup it had become almost colourless. To my own litmus-paper it was neutral, although Dr. Behr informs me he detected a very feeble acid reaction.

As determined by Dr. Behr, the filtered syrup when it came from the refinery contained, in 100 parts, 50 parts of dry substances and 40 parts of dry sugar. The alteration in the course of bleaching is seen in the following table:—

Effect of Ozone upon Filtered Syrup.

Dry Substance contains.	Unbleached.	Bleached.
Cane-sugar (by polariscope) ..	79·7 p.c.	80·0 p.c.
Inverted sugar	12·7 „	12·7 „

ACTION OF OZONE UPON THE COLOURING MATTERS OF PLANTS.

By ALBERT R. LEEDS.

In preceding numbers of the Chemical News for this year I have given the results obtained when ozonised oxygen was made to act upon flowers and plants. They were exposed to the action of a slow continuous current of ozonised oxygen, containing 1 m.grm. ozone per litre, during intervals varying from eighteen to thirty-six hours. The results, which were mainly negative, were so unsatisfactory that I repeated the experiments, with the aid of more efficacious apparatus for generating ozone.

One phosphorus-ozonator was employed to supply ozone; a second, without the phosphorus-cakes upon the disks, made a convenient arrangement to contain the flowers. As their stems were placed in vessels filled with water, and the bells were closed by the water contained in the jars, the atmosphere surrounding the flowers was kept moist, which was of importance in conducting the experiments.

I. In the first trial, in which many varieties of flowers were exposed during nineteen hours to the action of a current of 152 litres of air, containing in all 228 m.grms. of ozone, the bleaching effected was extremely imperfect.

II. 1200 Litres of Air passed over. (Total ozone 1·8 grms.)
At the end of five days—

Lantana, red	Yellow, and somewhat decomposed
Fuchsia, calyx, carnation-red	Yellow
,, petals, rose-pink	Dirty white
Petunia, magenta coloured	Calyx and petals partly bleached
Rose, crimson	Yellow
Agapanthus umbellatus	White at end of petals
Verbena, purple with white centre	Bleached
Pelargonium, scarlet	Bleached
Euphorbia, salmon coloured	Partly bleached
Fuchsia	Calyx and stamens yellow
Verbena, maroon coloured	Dirty white

A piece of calico with a pattern in bright green and black was completely bleached during the same interval, the green colour having disappeared completely, and the stain of the mordant only remaining where the black had been.

III. Ozonised Oxygen. (Exposure three and a half hours.)

Rose, light red	Nearly white; leaves white in spots
Fuchsia	Bleached to light red
Verbena, purple	White with purple spots
,, red	White with red spots
Petunia, purplish red	White in spots
Pelargonium, pink	White at end of petals
Bouvardia	Dirty white

No determination was made on the percentage of ozone during this particular experiment. But the same electrical ozoniser was employed as in other trials, when it had produced 24 m.grms. ozone per litre. A slow current of the gas was kept flowing during the course of the entire experiment.

Conclusion.—The colouring matters of both leaves and flowers of the species experimented upon were partly or wholly destroyed by ozone; but a considerable percentage of ozone is required to produce this result, or if such small amounts as are obtained in the customary methods of ozonising air by phosphorus are employed (1 to 3 m.grms. per litre), a large volume of ozonised air must be used, and a considerable interval elapse, before bleaching is effected.

THE BROMINE DERIVATIVES OF β-NAPHTHOL.

By ALFRED JOHN SMITH, B.Sc.

I HAVE succeeded in obtaining for the first time a mono- and tetra-bromine derivative from β-naphthol. The mono-bromide is formed by adding a mixture of bromine and glacial acetic acid drop by drop to a solution of β-naphthol in glacial acetic acid. On standing, it crystallises out in colourless needles, which can be washed from acetic acid with distilled water, and dried between filter-paper. The tetra-bromide is formed by adding excess of bromine to the solution of β-naphthol in glacial acetic acid; it crystallises out quickly. It is washed from excess of bromine with glacial acetic acid, then crystallised till quite white, washed with water, and dried in the same way as the mono-bromide.

The mono-bromide is decomposed by the action of heat, giving off copious fumes of hydrobromic acid. The evolution of HBr begins at about 130°; it melts at 84° C. On heating gradually up to 250° C. in an oil bath with excess of caustic potash or soda and a little water, β-naphthol is again formed.

The effect of an alkaline solution of potassium permanganate, at the heat of the water-bath, was tried both with the mono- and tetra-bromide; the excess of permanganate was destroyed with ferrous sulphate, the solution acidified with hydrochloric acid and extracted with ether. The ethereal extract deposited crystals on evaporation, which were submitted to sublimation. From the mono-bromo compound the anhydride of phthalic acid was obtained, and from the tetra-bromo compound the anhydride of mono-bromo-phthalic acid, thus showing that in the mono-bromo compound the bromine and hydroxyl are in the same benzene nucleus, and that in the tetra-bromo compound three bromine atoms and the hydroxyl are in the same benzene nucleus.

A full account of the research will shortly be offered to the Chemical Society. The research was carried on in the laboratory of the University of Zürich, under the supervision of Professor Merz.

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ANALYSTS IN JAPAN.

To the Editor of the Chemical News.

Sir,—Referring to the memorial which I presented at your office, I shall feel obliged if you will briefly notice it in your next issue.

A memorial to the Secretary of State for Foreign Affairs, signed by a number of the leading manufacturers and wholesale export drug and chemical merchants—amongst them Messrs. Howards and Sons, Allen and Hanburys, Burgoyne, Burbidges, and Co., Baiss Brothers and Co., Curling and Co., Dakin Brothers, Corbyn, Stacey, and Co., Herring and Co., Horner and Sons, May, Baker, and Co., Whiffin, &c.,—petitioning his lordship that Her Majesty's Government may take such steps as it may deem advisable to induce the Japanese Government to employ competent officers in the analyses of drugs and medicines, &c., at the ports of Japan open to foreigners; since, during the past two years, whole invoices of the purest and best qualities of such goods have been condemned as impure and prohibited for use and sale in that country, thereby causing heavy losses to merchants engaged in business in that country directly or indirectly.

The memorial is accompanied by several certificates of Professor Attfield and others confirming the purity of the goods condemned by the officials in the Government service of Japan.—I am, &c.,

J. Hartley.

9, Charterhouse Buildings, E.C.
August 14, 1879.

ACTION OF HEAT ON IODINE.

To the Editor of the Chemical News.

Sir,—Messrs. V. and C. Meyer, in the last Report of the German Chemical Society, give numbers which show a large diminution in the specific gravity of chlorine at the high temperatures they employed, and state that the behaviour of iodine gas was quite analogous to that of chlorine. These experiments must now be known to everyone, but the words with which the Messrs. Meyer conclude their most important series of papers calls, I think, for comment. They say:—

"For the present we will only refer to the fact, that the measurements of high temperatures, and the vapour density estimations based upon them by Deville and Troost, presuppose the unalterability of the density of iodine vapour. The inadmissibility of this premise being recognised, partly new interpretations will become necessary for the classical works of these experimenters."—(*Berichte der Deutsch.*, xii., 1431.)

But Deville and Troost, where they employed an iodine thermometer, also checked their result by an air thermometer, and the Messrs. Meyer infer from their experiments that at 1567° C. (their highest temperature) the molecular weights of oxygen and nitrogen still correspond to the formulæ O_2, N_2, usually ascribed to them.—(*Berichte der Deutsch.*, xii., 1428.)

Thus Deville and Troost found the boiling-point of sulphur by air thermometer to be 440° C. The specific gravity of iodine gas, accepting this temperature 440°, was found to be 8·70.

The boiling-point of cadmium, as found by air thermometer, was 856°; the iodine pyrometer gave numbers which, accepting 8·716 as specific gravity iodine gas, gave 860° as boiling-point of cadmium.

Finally, the boiling-point of zinc by air thermometer =1034°; by iodine pyrometer, assuming 8·716 to be the specific gravity of iodine gas, boiling-point of zinc =1040°.—(*Ann. de Chemie*, lviii., 257.)

From these numbers it would appear that at 1000° C. the specific gravity of iodine gas does not appreciably alter, but on that point we shall no doubt soon have information from Prof. Meyer, my only object in writing being to point out that the accuracy of the beautiful work of Deville and Troost is not wholly dependent on the indications of the iodine pyrometer.—I am, &c.

W. H. Deering.

1, Parrock Road, Gravesend.
August 18, 1879.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 2, July 14, 1879.

Direct Combination of Cyanogen with Hydrogen and with Metals.—M. Berthelot.—The author, having measured the heat of the formation of hydrocyanic acid and of cyanogen from their elements (−14·1 and −38·3), concludes that the synthesis of hydrocyanic acid from cyanogen and hydrogen ought to evolve a considerable quantity of heat. He finds that gaseous hydrocyanic acid may be heated to 550° for three or four hours in a sealed tube without betraying any marks of decomposition or dissociation. The author effected the direct combination of cyanogen and hydrogen by heating the pure dry gases in equal volumes in a sealed tube of hard glass to 500° to 550° for several hours. On opening the tube a loss of about one-seventh of the volume was apparent, due to the formation of a certain quantity of para-cyanogen. Potassa absorbed five-sevenths of the gas, and the residual one-seventh was found on analysis to consist of water almost pure. The volume of this residual hydrogen being sensibly equal to the original condensation (representing the change of a certain quantity of cyanogen into para-cyanogen) it follows that the gas absorbable by potassa is hydrocyanic acid exempt from free cyanogen. At a lower temperature the synthesis is less complete, and at greater heats a portion of nitrogen is set free. At 300° cyanogen combines with zinc, cadmium, iron if brought in contact in a sealed tube.

Organo-metallic Radicles of Tin: Stannbutyles and Stannamyles.—A. Cahours and E. Demarçay.—Not capable of useful abstraction.

Researches on the Effects of the Rheostatic Machine.—G. Planté.—The length of the sparks given by this machine is sensibly proportional to the number of condensers. With 80 condensers the author obtained sparks of 0·12 metre in length. If produced over a surface formed of a mixture of resin and paraffin they leave branching furrows, a representation of which is appended to the author's memoir.

Vapour of Bihydrosulphate of Ammonia.—M. Isambert.—The author shows that the experiments of MM. Engel and Moitessier (*Comptes Rendus*, lxxxviii.) are not conclusive.

Solution of Carbonic Oxide in Acid Cuprous Chloride.—H. Hammel.—The author has determined the quantity of heat disengaged in the reaction of carbonic oxide upon cuprous chloride, dissolved in hydrochloric acid.

Transformation of Tartaric Acid into Glyceric and Pyruvic Acids.—G. Bouchardat.—This change is produced by the action of sulphuric anhydride. The mucic, citric, and malic acids are decomposed in an analogous manner.

Isomerisms of Borneol.—J. de Montgolfier.—The author has determined the optical rotatory power of certain camphols, and of the camphor regenerated from them.

Bihydrochlorate of Terebenthen.—J. de Montgolfier.—The action of sodium upon the bihydrochlorate gives rise to a mixture of carbides of the formula $C_{20}H_{16}$ and $C_{20}H_{20}$.

Certain Derivatives of Indigotin.—E. Giraud.—The indolin of Schützenberger appears to be generated by a body identical, or, at least, closely connected, with the flavindin of Laurent. It is easily obtained by heating indigotin to 180° along with the hydrosulphite of soda and an excess of caustic soda.

No. 3, July 21, 1879.

Various Thermo-chemical Data.—M. Berthelot.—The author determines the formation heat of diamylen in the gaseous state at + 15·4 cal. The melting heat of glycerin is 3·91 cal., and its specific heat is 47·8 + 0·14 t (t being the temperature).

Phenomenon Analogous to that of Peltier.—E. Bouty.—If water acidulated with sulphuric acid is electrolysed between two thermometers covered with platinum the temperature is higher at the positive than at the negative pole. If the current is reversed a strong fall is observed at the pole which has become negative, but it disappears in a few moments. If the water is acidified with hydrochloric acid the initial phenomenon produced by the reversal of the current is a great rise of temperature at both poles.

Capacity of Voltaic Polarisation.—R. Blondlot.—Not susceptible of useful abstraction.

Action of Magnetism in Movement upon Static Electricity; Inertia of Static Electricity.—G. Lippmann.—The so-called phenomenon of Rowland (*Berlin Berichte*, 1876) is necessarily reversible, and this reversibility is a consequence of the impossibility of perpetual motion. Static electricity possesses a special mechanical inertia which is simply added to that of the electrised body.

Laws of the Variations of Atmospheric Electricity deduced from the Regular Observations made at the Observatory of Moncalieri.—P. F. Denza.—Atmospheric electricity presents daily in Piedmont two maxima following the rising and setting of the sun, at an interval of some hours. These two maxima are separated by a minimum which follows the passage of the sun over the meridian of the place. As regards the annual fluctuation the maximum value of the atmospheric tension falls in February, and the minimum in September. Before and after storms the electrometer almost always marks zero, but during their passage or proximity the tension is very great. Rain and snow increase tension more slightly and are often preceded and followed by electric diminution.

The action of fogs, hoar frost, and of the formation of clouds increases atmospheric electricity, though to a less extent than that of rain and snow. In calm and hot weather the lowest values are observed. South and especially south-easterly winds increase the electricity of the air; north winds have an opposite effect. Rain and snow are accompanied by negative electricity at least as often as by positive. The same proportion holds good for storms and to a less extent for rain and snow. Negative electricity is generally due to storms or rain at a distance, to the formation of clouds, or to a polar aurora. In the normal conditions of the atmosphere electric tension decreases with altitude.

Researches on Explosives: Combustion of Powder.—MM. Nobel and Abel.—The length of this paper renders it unfit for abstraction.

Experimental Researches on the Decomposition of Gun-cotton in Closed Vessels.—MM. Sarrau and Vieille.—The decomposition of gun-cotton gives rise to products which are few in number and very simple, namely, carbonic acid, carbonic oxide, hydrogen, and nitrogen.

Analytical Use of Sulphuretted Hydrogen in the Dry Way.—A. Carnot.—The author considers that this procedure, first recommended by Ebelmen, may be applied not merely to the separation, but also to the determination of a great number of metals. The sulphuretted hydrogen prepared by the reaction of hydrochloric acid upon iron sulphide passes through a washing bottle half full of water, is dried over calcium chloride, and acts upon the substance placed in a thin porcelain crucible heated to the required degree over a gas-burner. By heating very gently at first we may expel, without any loss of metal, in presence of the sulphurising gas the last traces of ammoniacal salts left by an imperfect washing of precipitates. At a higher temperature the simultaneous action of the hydrogen and of the sulphur vapours derived from the dissociation of the sulphuretted hydrogen perfectly sulphurises metallic oxides, carbonates, sulphates, and arseniates. The gas may thus be substituted for the use of alkaline sulphides at a high temperature.

Transformation of Hydrocellulose into Pulverulent Pyroxyles.—Aimé Girard.—Hydrocellulose placed in the same conditions as cellulose is nitrified to the same degree, yielding pyroxyle, whose composition closely agrees with hexa-nitro-cellulose.

Action of Boron Fluoride upon Aceton.—M. F. Landolph.—Aceton absorbs an equivalent of boron fluoride. The liquid thus obtained may be separated by fractional distillation into aceton fluoborides, α and β, and boraceton.

Determination of Urea.—C. Méhu.—In order to obtain in the cold all the nitrogen of the urea present in a urine, sugar must first be added to a known volume of the urine before the reaction of sodium hypobromite.

Iron Reduced by Hydrogen.—H. Moissan.—If the current of hydrogen is not dry, rapid, and long continued, and if the temperature is not uniform, the result is a mixture of iron, of ferrous and ferroso-ferric oxides.

Textile Colorist. Vol. i., No. 5, May, 1879.

This issue contains nothing of general interest.

No. 6, June, 1879.

Mr. J. H. Stebbins, of New York, has invented a new coal-tar dye, "toluol orange," the name of which indicates its source. He is also patenting a series of new dyes under the names of cresolidine, pyrogallidine, naphthylamidine, salicylidine, and picridine.

No. 7, July, 1879.

Detection of Cochineal upon the Fibre.—W. Stein recommends to boil the dyed goods under examination with solution of sulphate of alumina and let stand for about ten minutes. If cochineal be present the liquid will turn red, but without fluorescence. If the solution is then mixed with an equal volume of solution of bisulphate of soda no discolouration should take place. Alcohol boiled with a swatch of the goods will not take up any colour.

Gazzetta Chimica Italiana.

Anno ix., 1879. Fasc. 4 and 5.

On Nicotin.—Gustavo Andreoni.—The author questions the commonly received formula.

The rest of this issue consists of extracts from other chemical journals.

Bulletin de la Société d'Encouragement pour l'Industrie. Nationale.

No. 66, June, 1879.

Report presented by M. le Comte du Moncel, on behalf of the Committee of Economical Arts on M. E. Reynier's "Incandescence" Electric Lamp.—The author undertakes to combine the effects of incandescence with those resulting from the voltaic arc. He has been able to light five lamps with the current of a Bunsen battery of 30 elements, and even to keep burning for more than a quarter of an hour one of these lamps with the current of a Planté's polarisation battery of three elements.

Report by M. Debray on the Use of White Metal and Iridescent Laminæ in Embroidery.—The author uses wires of German silver in the manufacture of metallic laces. He likewise colours metallic foils for the same use by depositing upon them iridescent films of oxide of lead. He dissolves litharge in caustic alkali, and decomposes this liquid by a current of constant intensity, the positive pole of the battery being in communication with the metallic surface to be coated.

Report by M. Schützenberger on the Manufacture of Methylanilin on Vincent's Method.—This process has been already noticed.

Chemiker Zeitung.

No. 31, July 31, 1879.

The Gravimetric Determination of Fatty Matter in Milk.—Dr. F. Soxhlet.—The author proposes a special apparatus for the extraction of the dried milk-residuum with ether.

No. 32, August 7, 1879.

The Use of Ammonia Soda in the Ultramarine Manufacture.—C. Furstenau.—The author recommends the manufacturers of this soda to calcine it thoroughly, so that it may not contract further on ignition. The unequal and occasionally great shrinkage which these sodas undergo at a red heat is the cause of the fluctuating and often unsatisfactory results which they yield in the ultramarine manufacture.

Les Mondes, Revue Hebdomadaire des Sciences.

No. 14, July 31, 1879.

Endemic Diarrhœa of Cochin-China.—According to M. Colin, santonin is a complete cure for this obstinate disease, destroying the *Anguillulæ* by which it is occasioned.

New Remedy for the Phylloxera.—It is said that the ravages of this insect may be checked by planting the Eucalyptus in the neighbourhood of the vineyards. An anonymous article contends from the analogy of other imported insects, such as the house-bug, the cock-roach, the American apple blight, &c., that there are no grounds for expecting the spontaneous disappearance of the phylloxera.

No. 15, August 7, 1879.

Source of Muscular Power.—In reviewing Prof. Frankland's recent memoir on this subject M. Moigno remarks that the author is wrong in not letting electricity intervene, without which the transformation of chemical action into dynamical force is impossible.

Reimann's Färber Zeitung,
No. 29, 1879.

A New Blue Dye.—Reichenbach's wood-tar colour' Pittacal has been resuscitated by A. Grätzel, and it is now an article of commerce at the price of £4 per kilo., under the formidable name of "German-Imperial-Flower-Blue," with reference probably to the blue cornflower, which is said to be the favourite cognisance of the German Emperor. The pure base is insoluble in water, but dissolves in every acid, and the solutions can be diluted to any extent. The acetate is generally used for dyeing, dissolved in a little acetic acid diluted with water, and almost neutralised with ammonia. In this bath, silk and wool take a fine reddish blue without the aid of any mordant. Cotton and other vegetable fibres are prepared with a solution of tannin, followed by a solution of tartar emetic. The colours produced are perfectly fast.

Atti della R. Accademia dei Lincei.
Fascicolo 1.

Distribution of Cerium, Lanthanum, and Didymium.—S. Cossa.—This memoir refers, in the first place, to apatites, which present on examination with the spectroscope the absorption-line characteristic of didymium. The presence of cerium, lanthanum, and didymium has also been recognised in many apatites which do not present this characteristic of the absorption-spectrum. Small quantities of the same metals have also been found in limestones, in bones, and in the ashes of plants, and in the Scheelite of Traversella. The author, lastly, describes the absorption-spectra of certain didymiferous minerals.

Tungstate of Didymium.—S. Sella.—The crystals form small and imperfect octahedra of a yellow colour, shading into rose.

Preparation of Ammonialdehyds with Mixed Radicles.—R. Schiff.—The author describes the action of benzoic aldehyd upon chloral-ammonium and upon butyl-chloral-ammonium.

Chemical Nature of the Essential Oils of Laurel and of Bitter Almonds.—Prof. Fileti.—The author shows that these essences contain the nitrile—

$$C_6H_5CH\left\{\begin{matrix}OH.\\CN.\end{matrix}\right.$$

Derivative of Chloral-ammonium.—G. Tassinari.—The compound appears in white scales, which melt at 96° to 97°, and which turn yellow and are decomposed on exposure to light. Acetyl chloride and acetic anhydride do not form acetyl derivatives, but effect a profound decomposition.

Propyl-benzoic Acid.—E. Paterno.

Certain Derivatives of Camphotymol.—E. Paterno and F. Canzoneri.

Constitution of the Cymen of Cuminic Alcohol and its Thymols.—E. Paterno and P. Spica.

Cumophenol Carbonic Acid.—E. Paterno and G. Mazzara.—These four memoirs have been already noticed.

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Chemistry	HENRY E. ROSCOE, LLD., F.R.S.
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Materia Medica and Therapeutics	ALEXANDER SOMERS, M.R.C.S. DANIEL JNO. LEECH, M.D.
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Hygiene	ARTHUR RANSOME, M.D., M.A.
Practical Morbid Histology	JULIUS DRESCHFELD, M.D., M.R.C.P.
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III. DEPARTMENT OF EVENING CLASSES.

Classes conducted by the Professors and Lecturers of the College and external Lecturers are held during the Winter Months in nearly all the Arts and Science subjects.

The NEXT SESSION will COMMENCE:—In the Arts, &c., and Medical Departments, on the 7th October; and in the Evening Classes on the 13th Octobea.—Candidates for admission must not be under 14 years of age; those under 16 will be required to pass a preliminary examination in English, Arithmetic, and Elementary Latin.

Prospectuses of the several Departments may be obtained from Mr. Cornish, Piccadilly, and other Booksellers in Manchester, and at the College.

J. HOLME NICHOLSON, Registrar.

THE CHEMICAL NEWS.

Vol. XL. No. 1031.

ON RADIANT MATTER.*

By WILLIAM CROOKES, F.R.S.

To throw light on the title of this lecture I must go back more than sixty years—to 1816. Faraday, then a mere student and ardent experimentalist, was 24 years old, and at this early period of his career he delivered a series of lectures on the General Properties of Matter, and one of them bore the remarkable title, *On Radiant Matter*. The great philosopher's notes of this lecture are to be found in Dr. Bence Jones's "Life and Letters of Faraday," and I will here quote a passage in which he first employs the expression *Radiant Matter* :—

> "If we conceive a change as far beyond vaporisation as that is above fluidity, and then take into account also the proportional increased extent of alteration as the changes rise, we shall perhaps, if we can form any conception at all, not fall far short of Radiant Matter; and as in the last conversion many qualities were lost, so here also many more would disappear."

Faraday was evidently engrossed with this far-reaching speculation, for three years later—in 1819—we find him bringing fresh evidence and argument to strengthen his startling hypothesis. His notes are now more extended, and they show that in the intervening three years he had thought much and deeply on this higher form of matter. He first points out that matter may be classed into four states—solid, liquid, gaseous, and radiant—these modifications depending upon differences in their several essential properties. He admits that the existence of Radiant Matter is as yet unproved, and then proceeds, in a series of ingenious analogical arguments, to show the probability of its existence.†

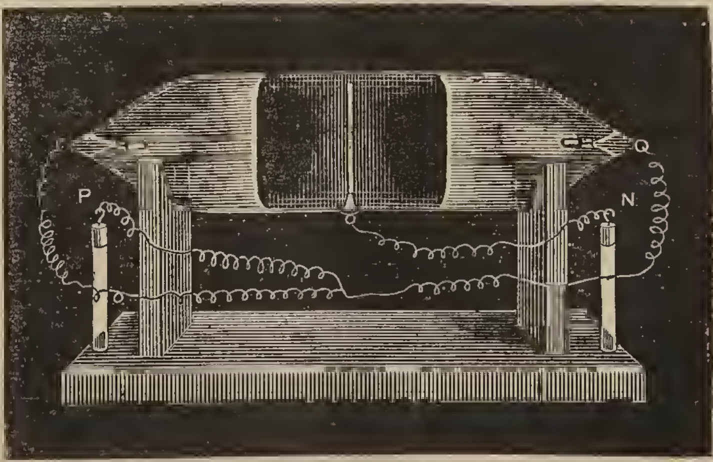
If, in the beginning of this century, we had asked, What is a Gas? the answer then would have been that it is matter, expanded and rarefied to such an extent as to be impalpable, save when set in violent motion; invisible, incapable of assuming or of being reduced into any definite form like solids, or of forming drops like liquids; always ready to expand where no resistance is offered, and to contract on being subjected to pressure. Sixty years ago such were the chief attributes assigned to gases. Modern research, however, has greatly enlarged and modified our views on the constitution of these elastic fluids. Gases are now considered to be composed of an almost infinite number of small particles or molecules, which are constantly moving in every direction with velocities of all conceivable magnitudes. As these molecules are exceedingly numerous, it follows that no molecule can move far in any direction without coming in contact with some other molecule. But if we exhaust the air or gas contained in a closed vessel, the number of molecules becomes diminished, and the distance through which any one of them can move without coming in contact with another is increased, the length of the mean free path being inversely proportional to the number of molecules present. The further this process is carried the longer becomes the average distance a molecule can travel before entering into collision; or, in other words, the longer its mean free path, the more the physical properties of the gas or air are modified. Thus, at a certain point, the phenomena of the radiometer become possible, and on pushing the rarefaction still further, *i.e.*, decreasing the number of molecules in a given space and lengthening their mean free path, the experimental results are obtainable to which I am now about to call your attention. So distinct are these phenomena from anything which occurs in air or gas at the ordinary tension, that we are led to assume that we are here brought face to face with Matter in a Fourth state or condition, a condition as far removed from the state of gas as a gas is from a liquid.

Mean Free Path. Radiant Matter.

I have long believed that a well-known appearance observed in vacuum tubes is closely related to the phenomena of the mean free path of the molecules. When the negative pole is examined while the discharge from an induction-coil is passing through an exhausted tube, a dark space is seen to surround it. This dark space is found to increase and diminish as the vacuum is varied, in the same way that the mean free path of the molecules lengthens and contracts. As the one is perceived by the mind's eye to get greater, so the other is seen by the bodily eye to increase in size; and if the vacuum is insufficient to permit much play of the molecules before they enter into collision, the passage of electricity shows that the "dark space" has shrunk to small dimensions. We naturally infer that the dark space is the mean free path of the molecules of the residual gas, an inference confirmed by experiment.

I will endeavour to render this "dark space" visible to all present. Here is a tube (Fig 1), having a pole in the centre in the form of a metal disk, and other poles at each end. The centre pole is made negative, and the two end poles connected together are made the positive terminal. The dark space will be in the centre. When the exhaustion is not very great the dark space extends only a little on each side of the negative pole in the centre. When the exhaustion is good, as in the tube before you, and I

Fig. 1.



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* A Lecture delivered to the British Association for the Advancement of Science, at Sheffield, Friday, August 22, 1879.

† "I may now notice a curious progression in physical properties accompanying changes of form, and which is perhaps sufficient to induce, in the inventive and sanguine philosopher, a considerable degree of belief in the association of the radiant form with the others in the set of changes I have mentioned.

"As we ascend from the solid to the fluid and gaseous states, physical properties diminish in number and variety, each state losing some of those which belonged to the preceding state. When solids are converted into fluids, all the varieties of hardness and softness are necessarily lost. Crystalline and other shapes are destroyed. Opacity and colour frequently give way to a colourless transparency, and a general mobility of particles is conferred.

"Passing onward to the gaseous state, still more of the evident characters of bodies are annihilated. The immense differences in their weight almost disappear; the remains of difference in colour that were left, are lost. Transparency becomes universal, and they are all elastic. They now form but one set of substances, and the varieties of density, hardness, opacity, colour, elasticity and form, which render the number of solids and fluids almost infinite, are now supplied by a few slight variations in weight, and some unimportant shades of colour.

"To those, therefore, who admit the radiant form of matter, no difficulty exists in the simplicity of the properties it possesses, but rather an argument in their favour. These persons show you a gradual resignation of properties in the matter we can appreciate as the matter ascends in the scale of forms, and they would be surprised if that effect were to cease at the gaseous state. They point out the greater exertions which Nature makes at each step of the change, and think that, consistently, it ought to be greatest in the passage from the gaseous to the radiant form."—*Life and Letters of Faraday*, vol. i., p. 308.

turn on the coil, the dark space is seen to extend for about an inch on each side of the pole.

Here, then, we see the induction spark actually illuminating the lines of molecular pressure caused by the excitement of the negative pole. The thickness of this dark space is the measure of the mean free path between successive collisions of the molecules of the residual gas. The extra velocity with which the negatively electrified molecules rebound from the excited pole keeps back the more slowly moving molecules which are advancing towards that pole. A conflict occurs at the boundary of the dark space, where the luminous margin bears witness to the energy of the discharge.

Therefore the residual gas—or, as I prefer to call it, the gaseous residue—within the dark space is in an entirely different state to that of the residual gas in vessels at a lower degree of exhaustion. To quote the words of our last year's President, in his Address at Dublin:—

> "In the exhausted column we have a vehicle for electricity not constant like an ordinary conductor, but itself modified by the passage of the discharge, and perhaps subject to laws differing materially from those which it obeys at atmospheric pressure."

In the vessels with the lower degree of exhaustion, the length of the mean free path of the molecules is exceedingly small as compared with the dimensions of the bulb, and the properties belonging to the ordinary gaseous state of matter, depending upon constant collisions, can be observed. But in the phenomena now about to be examined, so high is the exhaustion carried that the dark space around the negative pole has widened out till it entirely fills the tube. By great rarefaction the mean free path has become so long that the hits in a given time in comparison to the misses may be disregarded, and the average molecule is now allowed to obey its own motions or laws without interference. The mean free path, in fact, is comparable to the dimensions of the vessel, and we have no longer to deal with a *continuous* portion of matter, as would be the case were the tubes less highly exhausted, but we must here contemplate the molecules *individually*. In these highly exhausted vessels the molecules of the gaseous residue are able to dart across the tube with comparatively few collisions, and radiating from the pole with enormous velocity, they assume properties so novel and so characteristic as to entirely justify the application of the term borrowed from Faraday, that of *Radiant Matter*.

Radiant Matter exerts Powerful Phosphorogenic Action where it Strikes.

I have mentioned that the Radiant Matter within the dark space excites luminosity where its velocity is arrested by residual gas outside the dark space. But if no residual gas is left, the molecules will have their velocity arrested by the sides of the glass; and here we come to the first and one of the most noteworthy properties of Radiant Matter discharged from the negative pole—its power of exciting phosphorescence when it strikes against solid matter. The number of bodies which respond luminously to this molecular bombardment is very great, and the resulting colours are of every variety. Glass, for instance, is highly phosphorescent when exposed to a stream of Radiant Matter. Here (Fig. 2) are three bulbs composed of different glass: one is uranium glass (*a*), which phosphoresces of a dark green colour; another is English glass (*b*), which phosphoresces of a blue colour; and the third (*c*) is soft German glass,—of which most of the apparatus before you is made,—which phosphoresces of a bright apple-green.

My earlier experiments were almost entirely carried on by the aid of the phosphorescence which glass takes up when it is under the influence of the radiant discharge; but many other substances possess this phosphorescent power in a still higher degree than glass. For instance, here is some of the luminous sulphide of calcium prepared according to M. Ed. Becquerel's description. When the sulphide is exposed to light—even candlelight—it phosphoresces for hours with a bluish white colour. It is, however, much more strongly phosphorescent to the molecular discharge in a good vacuum, as you will see when I pass the discharge through this tube.

Other substances besides English, German, and uranium glass, and Becquerel's luminous sulphides, are also phosphorescent. The rare mineral Phenakite (aluminate of glucinum) phosphoresces blue; the mineral Spodumene (a silicate of aluminium and lithium) phosphoresces a rich golden yellow; the emerald gives out a crimson light. But without exception, the diamond is the most sensitive substance I have yet met for ready and brilliant phosphorescence. Here is a very curious fluorescent diamond, green by daylight, colourless by candlelight. It is mounted in the centre of an exhausted bulb (Fig. 3), and the molecular discharge will be directed on it from below upwards. On darkening the room you see the diamond

Fig. 3.

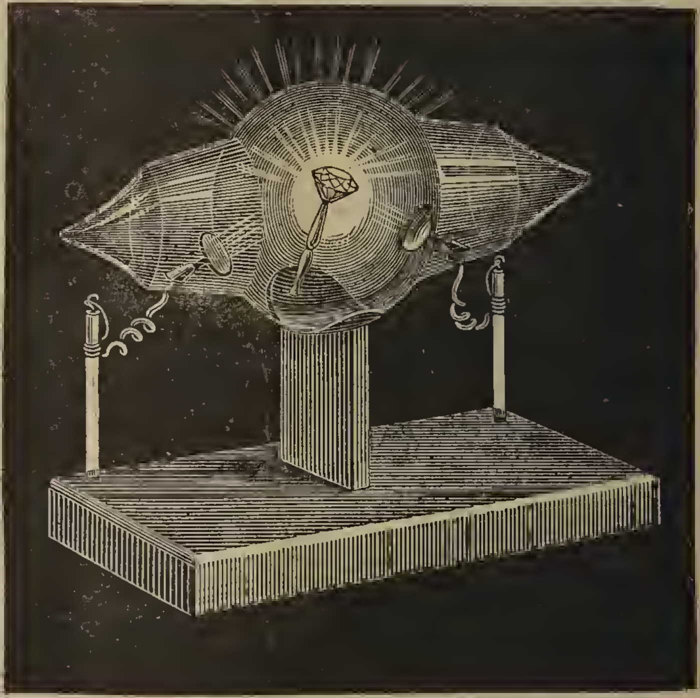
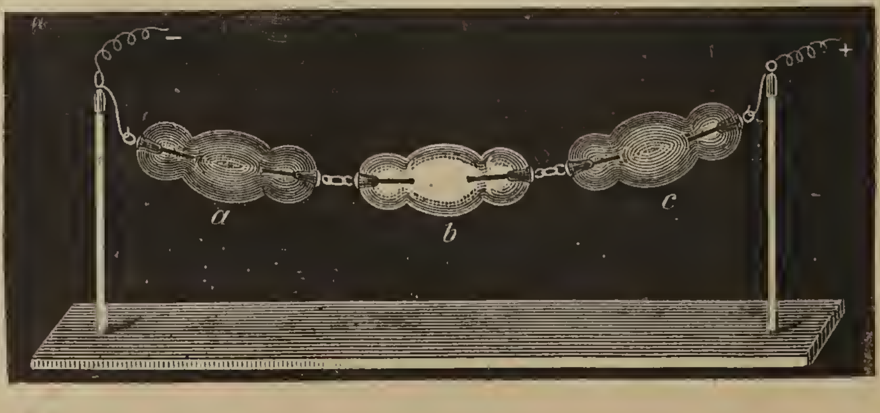


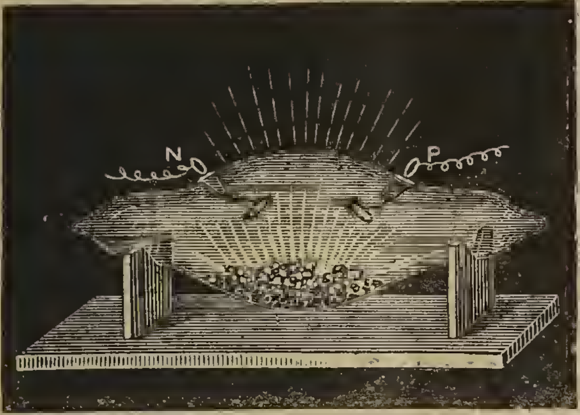
Fig. 2.



shines with as much light as a candle, phosphorescing of a bright green.

Next to the diamond the ruby is one of the most remarkable stones for phosphorescing. In this tube (Fig. 4) is a fine collection of ruby pebbles. As soon as the induction spark is turned on you will see these rubies shining with a brilliant rich red tone, as if they were glowing hot. It scarcely matters what colour the ruby is, to begin with. In this tube of natural rubies there are stones of all colours—the deep red and also the pale pink ruby. There are some so pale as to be almost colourless, and some of the highly-prized tint of pigeon's blood; but under the impact of Radiant Matter they all phosphoresce with about the same colour.

Fig. 4.



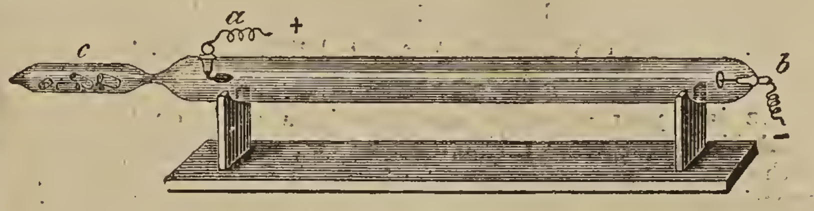
Now the ruby is nothing but crystallised alumina with a little colouring-matter. In a paper by Ed. Becquerel,* published twenty years ago, he describes the appearance of alumina as glowing with a rich red colour in the phosphoroscope. Here is some precipitated alumina prepared in the most careful manner. It has been heated to whiteness, and you see it also glows under the molecular discharge with the same rich red colour.

The spectrum of the red light emitted by these varieties of alumina is the same as described by Becquerel twenty years ago. There is one intense red line, a little below the fixed line B in the spectrum, having a wave-length of about 6895. There is a continuous spectrum beginning at about B, and a few fainter lines beyond it, but they are so faint in comparison with this red line that they may be neglected. This line is easily seen by examining with a small pocket spectroscope the light reflected from a good ruby.

There is one particular degree of exhaustion more favourable than any other for the development of the properties of Radiant Matter which are now under examination. Roughly speaking it may be put at the millionth of an atmosphere.† At this degree of exhaustion the phosphorescence is very strong, and after that it begins to diminish until the spark refuses to pass.‡

I have here a tube (Fig. 5) which will serve to illustrate the dependence of the phosphorescence of the glass on the degree of exhaustion. The two poles are at *a* and *b*, and at the end (*c*) is a small supplementary tube connected with the other by a narrow aperture, and containing solid caustic potash. The tube has been exhausted to a very high point, and the potash heated so as to drive off moisture and injure the vacuum. Exhaustion has then been recommenced, and the alternate heating and exhaustion repeated until the tube has been brought to the state in which it now appears before you. When the induction spark is first turned on nothing is visible—the vacuum is so high that the tube is non-conducting. I now warm the potash slightly and liberate a trace of aqueous vapour. Instantly conduction commences, and the green phosphorescence flashes out along the length of the tube. I continue the heat, so as to drive off more gas from the potash. The green gets fainter, and now a wave of cloudy luminosity sweeps over the tube, and stratifications appear, which rapidly get narrower, until the spark passes along the tube in the form of a narrow purple line. I take the lamp away, and allow the potash to cool; as it cools, the aqueous vapour, which the heat had driven off, is reabsorbed. The purple line broadens out, and breaks up into fine stratifications; these get wider, and travel towards the potash tube. Now a wave of green light appears on the glass at the other end, sweeping on and driving the last pale stratification into the potash; and now the tube glows over its whole length with the green phosphorescence. I might keep it before you, and show the green growing fainter and the vacuum becoming non-conducting; but I should detain you too long, as time is required for the absorption of the last traces of vapour by the potash, and I must pass on to the next subject.

Fig. 5.



(To be continued.)

Use of the Diffusion Method in the Study of the Phenomena of Dissociation.—L. Troost.—It has been already established that diffusion cannot solve the question of the existence or non-existence of bodies in the state of definite gaseous compounds. The experiments of M. A. Naumann and of MM. Wiedemann and Schulze can in no manner solve the question of the existence or non-existence of chloral hydrate as a definite gaseous compound. —*Comptes Rendus.*

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* *Annales de Chimie et de Physique*, 3rd series, vol. lvii., p. 50, 1859.

† 1·0 millionth of an atmosphere = 0·00076 millim.
1315·789 millionths of an atmosphere = 1·0 millim.
1,000,000 " " " =760·0 millims.
" " " " =1 atmosphere.

‡ Nearly 100 years ago Mr. Wm. Morgan communicated to the Royal Society a Paper entitled "Electrical Experiments made to ascertain the Non-conducting Power of a Perfect Vacuum, &c." The following extracts from this Paper, which was published in the *Phil. Trans.* for 1785 (vol. lxxv., p. 272), will be read with interest:—

"A mercurial gage about 15 inches long, carefully and accurately boiled till every particle of air was expelled from the inside, was coated with tin-foil 5 inches down from its sealed end, and being inverted into mercury through a perforation in the brass cap which covered the mouth of the cistern; the whole was cemented together, and the air was exhausted from the inside of the cistern through a valve in the brass cap, which producing a perfect vacuum in the gage formed an instrument peculiarly well adapted for experiments of this kind. Things being thus adjusted (a small wire having been previously fixed on the inside of the cistern to form a communication between the brass cap and the mercury, into which the gage was inverted) the coated end was applied to the conductor of an electrical machine, and notwithstanding every effort, neither the smallest ray of light, nor the slightest charge, could ever be procured in this exhausted gage."

"If the mercury in the gage be imperfectly boiled, the experiment will not succeed; but the colour of the electric light, which in air rarefied by an exhauster is always violet or purple, appears in this case of a beautiful green, and, what is very curious, the degree of the air's rarefaction may be nearly determined by this means; for I have known instances, during the course of these experiments, where a small particle of air having found its way into the tube, the electric light became visible, and as usual of a green colour; but the charge being often repeated, the gage has at length cracked at its sealed end and in consequence the external air, by being admitted into the inside, has gradually produced a change in the electric light from green to blue, from blue to indigo, and so on to violet and purple, till the medium has at length become so dense as no longer to be a conductor of electricity. I think there can be little doubt, from the above experiments, of the non-conducting power of a perfect vacuum."

"This seems to prove that there is a limit even in the rarefaction of air, which sets bounds to its conducting power; or, in other words, that the particles of air may be so far separated from each other as no longer to be able to transmit the electric fluid; that if they are brought within a certain distance of each other, their conducting power begins, and continually increases till their approach also arrives at its limit."

REPORT OF THE COMMITTEE ON THE CHEMISTRY OF SOME OF THE LESSER-KNOWN ALKALOIDS, ESPECIALLY VERATRIA AND BEBEERINE.*

Since last year investigations have been made on the alkaloids contained in *Veratrum album*, and *V. viride*, with the following general results; as the details of the experiments have already been communicated to the Chemical Society in two papers (*Journal of the Chemical Society*, 1879, i., pp. 405 and 421), it is unnecessary to quote them here.

Each kind of root was treated by the process described in last year's Report, viz., percolating with alcohol acidulated with tartaric acid, evaporating to a small bulk, treating with water to precipitate resin, filtering, alkalising with soda, and repeatedly shaking with a large bulk of ether, the ethereal solutions of alkaloids, &c., thus obtained being agitated with aqueous tartaric acid to remove the bases and then used over again. In each case a certain amount of flocculent alkaloidal matter was left undissolved by the ether, consisting mainly of an alkaloid analogous to jervine, but differing therefrom in certain respects, to which accordingly the name *Pseudojervine* is applied. The solutions of tartrates of alkaloids obtained were treated with soda and about an equal bulk of ether, whereby a large portion of the bases was dissolved in each case, but some left undissolved, especially with the *V. album* product; this insoluble matter contained pseudojervine, together with a little jervine, and in the case of the *V. album* product, a large quantity of an uncrystallisable base sparingly soluble in ether, to which the term *Veratralbine* is applied, as this body does not seem to be present in *V. viride* roots in any considerable proportion. The second ethereal solutions thus obtained deposited in each case crystals of jervine and a little of a new base to which the term *Rubijervine* is applied; the mother-liquors of these crystals dried up to varnish-like masses, which were not identical in the two cases; the product from *V. album* roots consisted essentially of veratralbine, with a minute quantity of an alkaloid forming veratric acid on saponification with alcoholic potash; this base was the only alkaloid of the saponifiable class present in the roots; presumably it was the *veratrine* obtainable from *V. sabadilla* seeds, as described in last year's Report, inasmuch as the mixture of this base and veratralbine obtained was powerfully sternutatory, whilst the peculiar tendency to provoke sneezing was lost on treatment with alcoholic potash (neither jervine, pseudojervine, rubijervine, nor veratralbine produces sneezing). The product from the *V. viride* roots was even more powerfully sternutatory than that from the *V. album* roots; it consisted, however, almost wholly of *Cevadine* (the second crystallisable alkaloid obtainable from *V. sabadilla* seeds, as described in last year's Report), not more than traces of either veratralbine or veratrine being contained; on saponification it yielded about the theoretical quantity of cevadic acid (the *methyl-crotonic acid* of Frankland and Duppa, identical with the *tiglic acid* of Geuther).

The following table shows the approximate quantities of the different alkaloids contained in a kilogramme of each root examined:—

	V. album.	*V. viride.*
Jervine.. ..	1·3 grammes	0·2 gramme
Pseudojervine	0·4 ,,	0·15 ,,
Rubijervine..	0·25 ,,	0·02 ,,
Veratralbine	2·2 ,,	Not more than traces
Veratrine ..	0·05 ,,	Trace; less than 0·004
Cevadine ..	Apparently absent	0·43 gramme
	4·20	0·80

The *V. album* roots were consequently about five times as rich in total alkaloids as the *V. viride* roots.

The following are the chief characteristics and properties of the new alkaloids examined; in many respects the statements of former observers concerning the alkaloids of these two kinds of roots appear to be erroneous, probably owing to the complete separation of jervine, &c., from the other substances now shown to be also present never having been previously effected.

Jervine.—When crystallised, $C_{26}H_{37}NO_3,2H_2O$: if the crystals separate from too hot or concentrated alcoholic liquors, somewhat less water is frequently present; readily becomes anhydrous at 100°; melts at 237° to 239° (purest specimens—corrected). Forms an almost insoluble sulphate, and a very sparingly soluble hydrochloride and nitrate. The gold salt is $C_{26}H_{37}NO_3,HCl,AuCl_3,H_2O$, the water of crystallisation being lost only slowly at 100°. With strong sulphuric acid dissolves to a yellow fluid, quickly darkening to a greenish brown, which soon becomes a fine green by absorption of a little water from the air if in an open dish; if in a test-tube, becomes green by cautiously adding minute quantities of water. Not sternutatory: not saponifiable. The formula assigned in 1837 by Will to jervine (isolated by Simon),—

$$C_{60}H_{45}N_2O_5(C=6,\ O=8),$$

modified by Gerhardt and his followers to $C_{30}H_{46}N_2O_3$, is considerably incorrect, the error being apparently due to an imperfect nitrogen determination (by volume), and to the presence of pseudojervine in the substance examined.

Pseudojervine.—Crystallises anhydrous, $C_{29}H_{43}NO_7$. Externally resembles jervine closely: melts at 299° (corrected: forms a sulphate crystallisable and soluble in water, especially when hot. Hydrochloride very sparingly soluble in water even when hot, provided no free hydrochloric acid is present. Gives with sulphuric acid exactly the same colour reaction as jervine. Not saponifiable: not sternutatory.

Rubijervine.—Crystallises anhydrous, $C_{26}H_{43}NO_2$: resembles jervine in appearance, and melts at nearly the same temperature (236° purest specimen—corrected). Sulphate and hydrochloride crystallisable and readily soluble in water, especially if warm. With strong sulphuric acid forms a yellow solution, becoming brownish yellow, brownish orange, brownish blood-red, and ultimately brownish purple by absorption of moisture: by cautious dilution with water the brownish blood-red fluid becomes successively crimson, purple, dark lavender, dark violet, light indigo. Not saponifiable: not sternutatory.

Veratralbine.—Amorphous, approximately $C_{28}H_{43}NO_5$. No crystallisable salts obtained as yet. With sulphuric acid dissolves to a yellow fluid, becoming brownish orange and brownish blood-red, with a strong green fluorescence; in this respect it closely resembles cevadine, which only differs in giving somewhat clearer tints, a crimson-magenta coloured fluid of a peculiarly beautiful and permanent shade being developed on absorption of a trace of moisture; veratrine (of Couerbe) gives precisely the same colours as cevadine, but the dark red solution formed before the crimson tint is developed by absorption of moisture does not exhibit any fluorescence. Veratralbine is not saponifiable, and is not sternutatory.

Currents of Ampère.—M. Trève.—Ampère asked if the molecular currents of magnets are entirely created in the magnetic substance during magnetisation, or if the magnetising cause merely determines a circulation of currents pre-existing in the metals in their natural state. He inclined to the latter opinion. The author thinks that there is every reason to admit, with Ampère, that the particular currents pre-exist in the magnetic metals, and that the current of the battery merely determines the circulation and the direction.—*Comptes Rendus.*

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* Read before Section B, British Association for the Advancement of Science, Sheffield Meeting, August 21, 1879. The Committee consisted of Mr. W. Chandler Roberts, F.R.S. (Secretary), Dr. C. R. Alder Wright, and Mr. A. P. Luff.

RESULTS OF AN EXHAUSTIVE CHLORINATION OF ISO-DINAPHTHYL.

By WATSON SMITH, F.C.S., F.I.C.

THE investigations of Ruoff and Merz have already shown that an exhaustive chlorination of naphthalene by continuous strong heating in sealed tubes with antimony pentachloride, or of perchlor-naphthalene with either antimony pentachloride or chloride of iodine, gives rise to a disintegration of the naphthalene molecule, so that perchlor-benzene, with perchlor-ethane and perchlor-methane, are formed. The formation of the two latter perchlorinated products is explained by assuming with Graebe (*Ann. Chem. Pharm.*, 149, 21) that the group $(C_4H_4)''$ contained in the naphthalene molecule, together with the benzene nucleus, is converted into perchlor-butane, which immediately after its formation. and at the high temperature, splits up into perchlor-propane and perchlor-methane, and the former again into perchlor-ethane and perchlor-methane. Thus:—

$$\begin{aligned} C_{10}H_8 + 4Cl_2 &= C_6Cl_6 + C_4H_{10} \\ C_4H_{10} + Cl_2 &= C_3Cl_8 + CCl_4 \\ C_3Cl_8 + Cl_2 &= C_2Cl_6 + CCl_4. \end{aligned}$$

(See Kraft and Merz, *Berichte der Deutsch.*, 1875, 1300.)

Diphenyl by exhaustive chlorination yields perchlor-diphenyl—

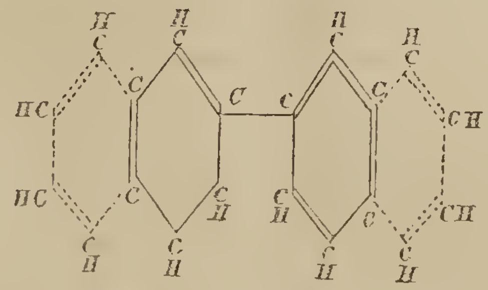
$$\begin{array}{c} C_6Cl_5 \\ | \\ C_6Cl_5, \end{array}$$

very difficult to sublime, giving feathery needles, which did not melt even at 270°. The chlorination of a large number of the most prominent members of the aromatic series by Merz in conjunction with others (Ruoff, Moe, &c.) has done perhaps more than any other line of research to demonstrate the truth involved in Kekulé's theory, by which all aromatic compounds are represented as containing the benzene nucleus, for by this method of exhaustive chlorination from every aromatic body treated (excepting diphenyl) perchlor-benzene has been obtained, and with regard to the by-perchlorinated products (perchlor-paraffin groups), these have also indicated the truth of the mode of the constitution-formulæ adopted.

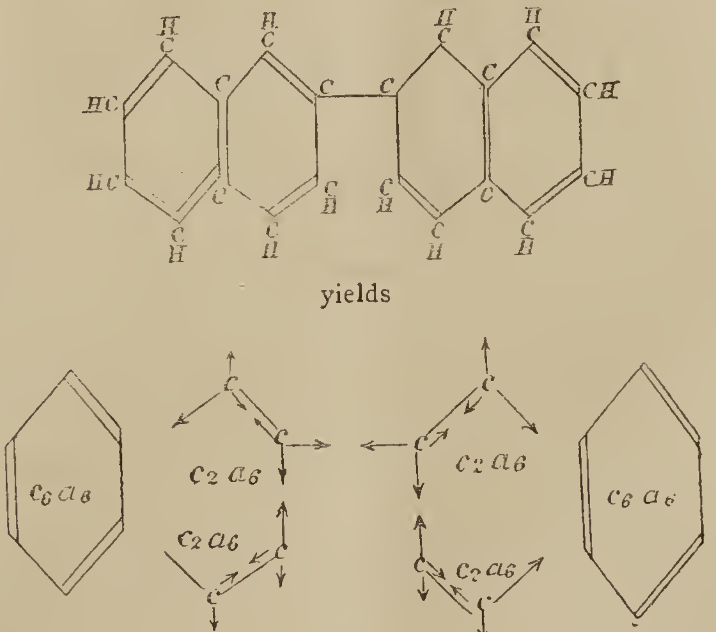
It was now thought interesting to attempt the perchlorination or exhaustive chlorination of iso-dinaphthyl. For this purpose the hydrocarbon, after being introduced into the perfectly dry tube, was treated with ten times its weight of antimony pentachloride, gradually introduced down a long funnel. The whole mass of the dinaphthyl was immediately turned black and frothed up strongly, evolving volumes of hydrochloric acid gas. When the whole of the pentachloride had been added, the tube was sealed up and heated first to a temperature of 150° for some two to three hours. On cooling and opening, a considerable pressure was manifested, resulting from accumulation of hydrochloric acid.

A stream of dry chlorine was now passed through the mass to convert all the trichloride formed into pentachloride. The tube was then again sealed up, and heated some two to three hours to 250°. On opening, still considerable pressure, but less than before. Again chlorinated, sealed, and heated to 350°. But little pressure, and on again heating to some 400°, after re-chlorinating, and re-opening, no pressure perceptible. The product—after well washing with excess of concentrated hydrochloric acid, and then with warm tartaric acid solution, and finally with water, till no more trace of acidity remained, by which all antimony compound was removed—was observed to be rather resinous. On sublimation of a portion a quantity of small needles was obtained, having an odour somewhat like camphor, and melting at about 182°, evidently perchlorethane. Perchlormethane was also most probably present in the oily portion. The mass was now once more treated with ten times its weight of antimony pentachloride. Further action immediately set in, with evolution of hydrochloric acid, proving that full perchlorination was prevented before by the protecting coating of antimony chlorides formed. After sealing up, and heating exactly as described above, a mass of long needles was observed as the final product. On washing as before, drying at 80°, and subliming, first small needles or prisms of prisms of perchlorethane, with odour of camphor, and melting-point of 182°, were obtained, succeeded by a large quantity of fine long needles melting at 220° to 223°, and evidently consisting of perchlor-benzene (C_6Cl_6). It is therefore proved that isodinaphthyl does not yield perchlor-diphenyl, or rather, that the diphenyl residue, which may be supposed to exist in dinaphthyl, suffers disruption in the process of perchlorination.

This is an interesting point, because Ruoff and Merz found that the diphenyl group alone, *i.e.*, diphenyl itself, could not be broken up by perchlorination, but yielded simply $C_{12}Cl_{10}$, perchlor-diphenyl. This diphenyl residue in iso-dinaphthyl can be rendered visible in the following formula:—



As I was not able to detect perchlor-methane in the products obtained, though I by no means assert it was not formed in the reaction to some extent, I must for the present consider that in all probability iso-dinaphthyl breaks up evenly into perchlor-benzene and perchlor-ethane, thus:—



Or $C_{10}H_7 - - C_{10}H_7$ yields $2C_6Cl_6 + 4C_2Cl_6$.

It would next be interesting to try the effect of exhaustive chlorination on the other two dinaphthyl isomerides in order to see if the different mode of binding together will denote a different mode of disruption of the molecule. The exhaustive chlorination of the new hydrocarbon phenyl-naphthalene, lately synthesised by me, may very probably give perchlor-diphenyl together with perchlor-ethane, or a mixture of perchlor-ethane and perchlor-methane. It seems very probable that on the one side the simple benzene nucleus may maintain a kind of equilibrium with the composite benzene nucleus on the other side of the link, and thus a perchlorinated diphenyl residue will remain, whilst the residue, $(C_4H_4)''$, will be split off into perchlorinated ethane, or methane and ethane groups. The solution of these latter problems will occupy me next, and I hope soon to be able to give a further report on the subject. I ought also to mention that after the first stage in the isodinaphthyl chlorination, when I obtained a resinous product, I dried a portion of this, after well washing as detailed, and on sublimation obtained crytals of perchlorethane, but not at all abundantly. A portion of the body dissolved in petroleum spirit, boiled with animal charcoal, filtered, and evaporated to dryness, gave apparently small round warty masses, which the magnifying glass showed to consist of stellate prismatic groups. It is possible this body may be perchlor-isodinaphthyl, and this possibility I shall investigate, as also that of the formation of perchlor-phenyl-naphthalene.

University Laboratory, Zürich,
August 11, 1879.

IS OZONE PRODUCED DURING THE ATMOSPHERIC OXIDATION OF PHOSPHORUS?

By C. T. KINGZETT.

I am chiefly induced to make the present brief communication from a conviction that most chemists believe and teach at the present time that ozone is produced during the atmospheric oxidation of phosphorus, just as a time ago it was believed and taught that the same substance is produced during the atmospheric oxidation of turpentine and other terpenes. I should, however, have deferred any communication of my own upon the subject until I might have had a better opportunity of practically investigating it, but for reading several interesting papers by Mr. A. R. Leeds, which have been printed in these pages from time to time.

On the face of things, it appears to me that one would not expect ozone to be formed by the aërial oxidation of phosphorus now that we understand the constitution of ozone, and since peroxide of hydrogen is the only known agent which resembles ozone in its general properties, and since, further, peroxide of hydrogen is now known to be produced in various processes of slow oxidation, it is this substance which should be more naturally expected to be produced in connection with the oxidation of phosphorus.

In a paper on a "New Reaction for Iodates and Iodides," M. Corne states[*] that the water in which phosphorus has been kept for some time liberates iodine from solutions of these substances, and he, as I think, illogically concludes that this behaviour is due to the presence of phosphorous acid. As a matter of fact, the reaction is characteristic of peroxide of hydrogen. This is important, if it be remembered that ozone is not soluble to any considerable extent in water, and that this is the only other substance which, as a product of the oxidation of phosphorus, could give the same reaction. This test, however, is not conclusive as regards the nature of the active agent, since there is a controversy as to the solubility of ozone in water. It will be remembered Marignac demonstrated that the formation of the active agent requires the presence of water, and this in itself is a further reason for regarding it as peroxide of hydrogen.

Mr. A. R. Leeds,[†] who regards the active agent as ozone and writes of it as such, has described an apparatus by the use of which it may be more freely obtained than usual, and he finds that not only is it produced by thd passage of air or oxygen over phosphorus partially submerged in water, but that it may also be obtained, and in greater quantity too, by using an acidulated solution of potassic dichromate instead of water. He found that the best solution to employ was one containing in every 1250 c.c. 150 c.c. H_2SO_4 and 25 grms. of the dichromate. By connecting the vessels containing the phosphorus and this that the amount of active agent generated in the first of a mixture by appropriate tubes, Mr. Leeds ascertained, series of such vessels is increased by causing the air containing it to pass through the second and third vessels and so on. The temperature necessary for maximum production he fixed at about 24° C. Operating in this way, he obtained a gaseous product containing about 2·5 milligrms. of estimated ozone (?) to the litre of air.

The estimations were made by first washing the air in water, and then passing it into a solution of potassic iodide, determining the iodine thus set free by means of a standard solution of sodic hyposulphite. Now, although at first blush it might be thought that the washing water would remove any peroxide of hydrogen which might be held in the gas in the vesicular state, yet as a matter of fact this is by no means necessarily the case. Indeed, all the erroneous views which were once prevalent upon the nature of antozone were due to the same misleading notion. Antozone is now known to be peroxide of hydrogen, but from the fact that it was obtained diffused through large volumes of air, and that ordinary washing with water did not effectually remove it, it was regarded for a long time as a new substance. It is, therefore, I submit more than probable that the washing with water to which Mr. Leeds subjected his gaseous product did not remove the peroxide of hydrogen[*] therefrom, and so he estimated it as, and called it, ozone.

Not rarely Andrew's experiments are referred to as establishing the idea of ozone being a product of the oxidation of phosphorus. But if his research[†] be carefully studied, it will be observed that he gives no proof of the ozonic nature of his product. He merely showed that his active air obtained from phosphorus lost its properties *when agitated with water*, suggesting to my mind that these were due to peroxide of hydrogen which the water abstracted during the experiment.

Most practical chemists are aware of the great difficulty experienced in perfectly separating two gases by passing them through a solution in which one of them is soluble. For instance, it has been noticed (and more particularly, I believe, by Sir B. C. Brodie in some of his later researches) that when a mixture of carbonic oxide and carbonic anhydride gases is passed through a solution of potash in order to remove the latter one, the process is ineffectual except in those cases where some special precautions are observed. To be effectual it is requisite that the potash solution should present a very large surface to the mixed gases, such as is only obtained by conducting them through a long tube filled with the fluid. The least reflection on the nature of a gas will satisfy the mind as to the necessity of this proceeding for bringing every particle of the gaseous mixture into intimate contact with the fluid.

In addition to the objections which I have already pointed out to viewing the active agent produced in the atmospheric oxidation of turpentine as ozone, there are other considerations which lead to the other conclusion, viz., that the active agent is peroxide of hydrogen. *There is no known process of slow oxidation which has been established to produce ozone.*

In the several instances which have been written about from time to time the different observers have always relied upon properties common to the two substances, and have never instituted volumetric investigations which are alone sufficient to decide the question. On the other hand, there are known several processes of slow oxidation in which peroxide of hydrogen is formed, as, for instance, those relating to ether and the terpenes; and I believe that as peroxide of hydrogen is formed in each of these cases as a secondary product due to the action of water upon a peroxide, so also the oxidation of phosphorus by air gives rise to an oxide which generates peroxide of hydrogen by contact with water. So far as I remember

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[*] *Journ. de Pharm.*, [4], xxii., 425.

[†] Chemical News, vol. xxxix., p. 157; also vol. xl., p. 70.

[*] In his last paper he identifies this substance among the other products.

[†] *Philosophical Transactions*, 1856, p. 1.

the experiments of D. J. Boche* upon this last-named subject, they bear out my view. At any rate the active agent produced in the aërial oxidation of phosphorus has never been proved to possess the special volumetric relations of ozone, and until this is done it seems to me a pity that in chemical text-books such very decided statements should be made as are to be found.

ON THE COMPOSITION OF A WELL-WATER AT GROUVILLE WHICH OCCASIONED AN OUTBREAK OF TYPHOID FEVER.

By THOS. M. MORGAN, F.I.C., &c.

The Female Orphan's Home of Grouville, one of the parishes on the eastern part of this island, was visited in the latter end of last May by a severe outbreak of typhoid fever: out of nearly one hundred and fifty inmates no fewer than twenty-five were prostrated by the disease.

The establishment is situated in the country, pretty well isolated, and far removed from any sewers; there was, moreover, no fever in the neighbourhood, and therefore the source of this was probably to be found on the spot. The well yielded water of a pleasant taste, perfectly clear and colourless, and much esteemed; it therefore did not lie under much suspicion, but was nevertheless sent to me for analysis. It contained neither nitrites nor ammonia, and decolourised very little permanganate. Analysis showed per million parts:—

Total Solids.	Chlorine.	N as Nitrates.	C Organic I.	C Organic II.	O of $KMnO_4$ consumed.
1378	326·6	26	2	1·8	0·186

The dissolved gases per litre were:—

CO_2.	O.	N.
58 c.c.	4 c.c.	15 c.c.

The solid residue was highly deliquescent, from the abundance of calcium nitrate present; it also contained much sodium chloride, and the carbonates of lime and magnesia.

The determination of chlorine in the waters here does not afford much information in respect of sewage contamination, as nearly all the wells, even though much above the sea-level, contain it in abundance; the quantity in this is, however, nearly twice as great as in a new well made a hundred yards distant, the analysis of which is given below. The nitrogen was determined by Frankland's method, except that the chlorine was not previously abstracted: the nitric oxide obtained from two or three samples of this water, and in this way was found to be quite pure. The carbon was determined by an organic analysis of the residue and the dissolved gases by Bunsen's method.

The quantity of nitrates here found was remarkable, and so far as the analysis is concerned they alone distinctly indicated a bad water. Tested as it came from the pump with ferrous sulphate and sulphuric acid, the usual indication of their presence might be indistinctly seen. Still, many waters here contain nitrites and nitrates often in considerable quantity. When kept for a few days it acquired an odour, and when this was rendered more sensible by warming in a flask, it at once suggested to me the smell of putrid urine. Another quantity, kept in a clear glass bottle and exposed to the light, gave rise to a slight deposit of green matter, which under the microscope was seen to consist of detached green cells.

The water was condemned, and the inmates of the Home were told to abstain from drinking it. Subsequently several fresh cases of fever occurred, but the patients acknowledged that, notwithstanding the prohibition, they had still used the old well. One of the older girls, who had carefully kept the younger ones from it, ventured to take some herself, but was seized with the disease and died of it. The pump was then removed, and after that there were no more attacked, nor were there any sufferers among twelve young children fed solely on milk. Altogether there have been thirty-nine cases.

The soil in this locality consists of a yellow loam from 15 to 20 feet thick, and below that there is about an equal thickness of coarse yellow sea-sand or gravel, by sinking wells into which water is obtained.

This particular well was sunk in the courtyard of the establishment, and afterwards covered in. About 60 feet distant a cesspool had been constructed, 6 feet deep. It had long been used, but for the last three years had received urine and soap-suds exclusively. After the outbreak of fever it was emptied and filled up: from this the well is supposed to have received its pollution. Last winter, after some heavy rains, it became very muddy, and was accordingly pumped out and cemented part of the way down; perhaps this interference facilitated the entrance of impurities. Two bore wells within 25 feet of this one yielded waters containing much ammonia and nitrites. A bore well 100 yards from the cesspool, and in another direction, gave water of the following composition per million parts:—

Total Solids.	Chlorine.	Ammonia.	N as Nitrites and Nitrates.	C Organic. I.	C Organic. II.
840	180	traces	5·5	2·9	2·8

Dissolved gases in a litre:—

Carbon Dioxide.	Oxygen.	Nitrogen.
32·5 c.c.	3·5	13

A later analysis, when the water had been in use for some time, and when the completion of the well had exposed it more to the atmosphere, showed the quantities of carbon and nitrites had slightly decreased, and a corresponding increase in the nitrates.

It is important to note—as Dr. Bull, the consulting physician to the establishment, remarks, and he is thoroughly conversant with its medical history from the beginning—that there has never been a decided case of typhoid there before, and hence, as the sewage cannot have proceeded from typhoid patients, it is possible for this disease to arise *de novo*.

The Laboratory, Victoria College, Jersey.

NEW PROCESS FOR THE RAPID ESTIMATION OF PURE SUGAR IN RAW AND REFINED COMMERCIAL SUGARS.*

By P. CASAMAJOR.

(Continued from page 76.)

Part II.

I had given up hope of success, when on passing before No. 71, Maiden Lane, I saw at a window a number of bottles, labelled *Diamond Methal*, which proved to be methylic alcohol. I determined to try if methylic alcohol would answer better than the ethylic, and purchased a gallon of the product. This stood at 92·5° by the alcohometer, and even at this strength the gummiest sugar could be cleansed by mixing with this spirit and stirring the mixture. On saturating it with sugar, and placing the solution in the tube of a Ventzke saccharometer, the indication was 1·7, which is less than corresponds to ethylic alcohol of the same density.

These first trials were very encouraging, and those that followed were not less so. Without recounting now the experiments that were made, I may state that, by the use of methylic alcohol, I finally succeeded in obtaining, with

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* *Deutsch. Chem. Ges. Ber.*, vi., 439.

* Read before the American Chemical Society, June 5, 1879.

an alcohometer, results that agree very closely with those of the optical saccharometer, with cane sugars of all classes, from the highest to the lowest.

The explanations already given concerning the use of ethylic alcohol of various strengths, saturated with sugar, and the effects that water and the soluble impurities have in lowering their alcohometric degrees, render superfluous any account of similar experiments with hydrate of methyl. I may briefly state that, after making a great number of trials, I found that methylic alcohol of 83½° of the alcohometer,[*] when saturated with sugar, stands at 77·1°, and that this solution is the one that has given the most accurate results.

This saturated solution is quite easily obtained by taking methylic alcohol standing at 83½° by the alcohometer, and saturating it with sugar, by the process which Numa Grar suggested to Payen. This consists in shaking up the alcohol with powered sugar. Grar made his powdered sugar by grinding it in a mortar in presence of alcohol. I have generally used dry *extra-powdered* sugar. When this cannot be had, grinding in a mortar is an excellent way of getting the sugar in fine particles, which are very necessary for obtaining a saturated solution in a short time. When very finely powdered sugar is shaken up with either ethylic or methylic alcohol, the finest particles are dissolved almost immediately, while the coarser grains fall to the bottom, leaving the liquid quite clear after standing a minute or two. When the alcohol clears up in this way, it is an indication that it is not saturated, and an additional quantity of sugar should be shaken up with it. This is repeated until the mixture remains cloudy for at least two or three minutes after adding finely powdered sugar. When this takes place, the liquid is saturated, and a further addition of sugar will not increase its density. By operating in this way, we may obtain saturated alcohol in 10 or 15 minutes, while, by hanging sugar crystals in the solution, I have not been able to obtain the maximum of density in less than two days. When we are about to use the solution, it is advisable to shake it up a little while before using it, and, after the sugar has been deposited, to take the alcohometric degree. This degree cannot be higher than that shown by previous observations, but it may become lower, if the bottle is not tightly closed, as the alcohol evaporates, leaving a residuum containing a greater proportion of water. There is no use in placing chloride of calcium tubes on the cork of the bottle in the vain hope that, in this way, water may be absorbed from the atmosphere. The lowering of the alcoholic degree takes place principally by the evaporation of the spirit, and nothing can replace tight stoppers. The tin cans, with screw caps, that are used for refined petroleum, are well adapted for holding methylic alcohol, and of these Coleman's *elevated swinging cans* are the most convenient for holding our standard solution.

When on testing the saturated alcoholic solution, we find that the degree is lower than required, we may raise it by adding more alcohol. The addition of alcohol causes the precipitation of a part of the sugar in solution, so that the quantity of alcohol to be added should be somewhat less[†] than the quantity to be added to a mixture of alcohol and water, of which we desire to raise the degree by the addition of stronger alcohol.

If we have a certain volume, V, of alcohol and water, whose alcohometric degree is d, and we wish to raise this degree to D, with strong alcohol of degree Δ, if the volume of the latter alcohol to be added is call x, we shall have—

$$\mathrm{V}d + x\Delta = (\mathrm{V}+x)\ \mathrm{D},$$

whence

$$x = \frac{\mathrm{V}\ (\mathrm{D}-d)}{\Delta - \mathrm{D}}$$

If we have 1000 c.c. of alcohol at 81, and we wish to raise the degree to 83½, with alcohol of 92 per cent, then $d=81$, $\mathrm{D}=83\frac{1}{2}$, $\mathrm{V}=1000$ and $\Delta=92$, and the volume of alcohol of 92 to be added, is—

$$x = \frac{1000 \times 2{\cdot}5}{8{\cdot}5} = 294{\cdot}1 \text{ c.c.}$$

If the addition of alcohol has been too great, we may diminish the degree by adding water very cautiously, and stirring up the mixture with an excess of sugar. To obtain the quantity of water, we may use the above formula but we must note that $\Delta=0$, and, as both numerator and denominator have become negative quantities, we may change the signs, and we shall have:—

$$x = \frac{\mathrm{V}\ (d-\mathrm{D})}{\mathrm{D}}.$$

These particulars have been entered into because of the great importance of obtaining saturated solutions which do not deviate too widely from 77·1° of the alcohometer. Too much attention cannot be given to this, as otherwise it is not possible to obtain correct results.

Next in importance is the weight of commercial sugar to be taken for 100 c.c. of the methylic solution saturated with sugar. In the process proposed by M. Dumas, 50 grms. of sugar are stirred with 100 c.c. of his standard solution. At the outset of the experiments on this process, I found that one obvious cause of error was the imperfect solubility of the impurities of commercial sugars in this standard solution. I was led then to grind the sugar down in a mortar as thoroughly as possible, so as to break up all the lumps and crush the large crystals, to allow everything to dissolve that would. I used for this quite a heavy pestle, of a size quite disproportionate to that of the mortar. By this thorough crushing much less sugar is used than M. Dumas proposed. It is an easy matter to determine the quantity of sugar to be used in a test. At first we may take an arbitrary quantity, and note the result, which may be corrected by the following considerations. The lowering of the alcohometric degree depends, as we have said, on the water and the soluble impurities present in the sugar. If we take a certain weight of sugar, say 45 grms., we may find by the alcohol process that the result is 91·5 per cent of sugar. If we test the same sugar by the optical saccharometer and find 93 per cent of sugar, we know that the alcohol process has given us too low a result, and this beause the solution was too dense. Our result shows in the sugar:—100 − 91·5 = 8·5 of impurities and water, while we ought to have had 100 − 93 = 7. We must then, to obtain 93, take a weight equal to—

$$\frac{45 \times 7}{8{\cdot}5} = 37{\cdot}05 \text{ grms.}$$

(To be continned.)

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[*] Since this paper was written, I have found the following interesting coincidence:—The alcohometric degree 83½ corresponds to a specific gravity of 0·85315 (Prof. MacCulloch's tables for Tralle's alcohometer). On consulting Dr. Ure's table for methylic alcohol (*Phil. Mag.* [3], xix., 51), it may be seen that specific gravity 0·8531 corresponds to 87 per cent of methylic alcohol. Now, in the first part of this paper, I have said that ethylic alcohol of 87 per cent, saturated with sugar, gives the results which agree most closely with those of the optical saccharometer.

[†] I usually take 0·8 x.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 4, July 28, 1879.

Researches on the Refraction of Obscure Heat.—P. Desains.—In the case of a flint-glass prism acting upon the rays of incandescent platinum the spectrum is symmetrical with respect to the ordinate of the maximum as far as about 1° from this ordinate, either to the right or the left. When this limit is passed the ordinates representing thermic intensities decrease rather more rapidly on the side of the luminous part of the spectrum than of the other. If crown glass prisms are used this symmetry no longer occurs.

Chloral Hydrate.—A. Wurtz.—When vapour of water and vapour of anhydrous chloral meet under such circumstances that no condensation takes place the mixture does not occasion the slightest rise of temperature. Hence the author concludes that no combination takes place and that the dissociation of the vapour of chloral hydrate is complete not merely at 100°, but under a reduced pressure even at 61°.

Observations on MM. Nobel and Abel's Memoir on Explosives.—M. Berthelot.—The author criticises the chemical equations representing the destruction of the explosive bodies, the measure of the heat disengaged, and the presence of potassium hyposulphite among the resulting products.

Researches on Samarium, the Radicle of a New Earth extracted from Samarskite.—Lecoq de Boisbaudran.—The spectrum of this metal is distinguished from that of the decipium of M. Delafontaine by the absence of the intense ray 478, and by the presence of the strong blue bands 480 and 463·5, the former of which covers the decipium ray 478, and lastly by the constant presence of the very strong band 400·75. The purification of the oxide of this metal is so tedious that the author has not yet obtained a quantity sufficient for the determination of its chemical properties.

Report on the Experimental Researches of M. Stanislas Meunier Relative to Meteoric Nickeliferous Irons and to the Native Iron Carbides of Greenland.—MM. Fremy, H. Sainte-Claire Deville, Des Cloizeaux, Debray, and Daubrée.—The facts advanced justify the name of "veiny" (*filoniennes*) applied to concreted syssiderites. They even enable us to foresee that this name may be applied not merely to the numerous holosiderites remarkable for their crystalline condition, but even to the greater part of the metallic granulations of the sporadosiderites. The observations concerning the masses of Greenland compel us to admit that the internal layers of our globe, whence these masses are derived, are deeply impressed with a veiny character, all the rocks there being impregnated with concretions the result of reactions analogous to those which in ancient geological epochs gave rise to the formation of deposits of tin and of oligist. If we thus admit the analogy between meteorites and the deeper masses of our globe we recognise that the geological part of chlorine made known by Ch. Sainte-Claire Deville in his *Etudes sur les Volcans* is strikingly corroborated.

Action of Light upon Batteries.—H. Pellat.—A Daniell element whose copper is very clean is quite insensible to light. It is not the same if the copper is modified by oxidation or by the formation of a salt on its surface. Two Daniell elements were prepared as standards of electromotoric force, the sulphates being contained in two concentric glass vessels. These elements, perfectly transparent, were kept for five months; the zinc was not affected but the copper became coated with verdigris. Nevertheless, the elements retained their original force when the measurement was effected in the shade, but on exposure to the sun it was diminished by one-fortieth of its value. This variation ceased when the sun's rays were intercepted by a screen. This phenomenon is not due to a rise of heat, for the immersion of the battery in water at 50° produced no sensible effect, and a red glass which transmitted half the solar thermic radiations acted like an opaque screen. The luminous action renders the copper less positive.

Refrigerating Power of the Air at High Pressures.—A. Witz.—The law of Dulong and Petit represents exactly the facts up to a pressure of 1200 m.m.; at 1600 m.m. the exponent of pressure requires to be nearly doubled; beyond that point it returns towards its first value, which it reaches about 6400 m.m.

Distillation of a Heterogeneous Liquid.—L. Troost.—In the distillation of a mixture of chloral hydrate and chloroform it is the water which distils with the chloroform as long as this exists in sufficient quantity. Nevertheless at 61° the maximum tension of the watery vapour is inferior by 50·2 m.m. to that of anhydrous chloral. If the anhydrous chloral remains in the retort with the chloroform though its vapour-tension is greater than that of water it is retained by a true chemical action. MM. Engel and Moitessier believe that the vapour which distils with chloroform at 61° contains at once water and anhydrous chloral. This is not the case.

Determination of Organic Matter in Natural Waters.—G. Lechartier.—The author, after having criticised the process of Prof. Frankland and shown that the evaporation with sulphurous acid occasions a loss of nitrogen, proposes to evaporate with magnesia, thus expelling all ammonia present in ammoniacal salts, and then to determine the total nitrogen present. A separate determination of nitric nitrogen gives the organic nitrogen as difference.

Thermo-chemical Study of Dissolved Alkaline Sulphides.—P. Sabatier.—The reaction of an alkali upon the hydrosulphate of a sulphide gives rise to a very sensible liberation of heat, the sign of the formation, in concentrated liquids of a certain dose of neutral sulphide.

Dissociation of Ammonium Hydrosulphate.—MM. Engel and Moitessier.—A reply to M. Isambert. A mixture of hydrogen sulphide and of ammonia in the cold is entirely absorbed by water. If the solution is heated the hydrogen sulphide escapes first, and is accompanied by but little ammonia.

Calcination of the Dregs of Beet-roots.—C. Vincent.—The author maintains, in opposition to MM. Duvillier and Buisine, that his process is adequate to the preparation of considerable quantities of hydrochlorate of dimethyl-amine in a state of purity at least equalling that of the present commercial product.

Detection of Medicinal and Poisonous Substances in the Saliva.—A. Gabriel Pouchet.—In the case of patients suffering from lead poisoning lead was easily detected in the saliva. No arsenic could be detected in the case of diabetics under an arsenical treatment, nor could any trace of sugar be found. In *Morbus Brightii* albumen was present in the saliva.

The Soils of Dombes.—M. Nivet.—Remarkably poor soils which are kept under water for two seasons and are planted with oats in the third.

Experiments on the Production of Milk.—M. Lami.—The author investigates the comparative influence of milking twice or thrice daily. He considers the latter system, other conditions being the same, more favourable to the production of butter.

No. 5, August 4, 1879.

Remarks on M. Wurtz's Note on Chloral Hydrate.—M. Berthelot.—The author points out that the method pursued by M. Wurtz in his experiments is not applicable when the amount of heat liberated is inconsiderable. The heat lost by radiation, contact, or conductibility is much greater than the quantity sought to be detected.

Normal Thermic Spectrum of the Sun, and of the Incandescent Platinum Lamp (Bourbouze Lamp).—M. Mouton.—As regards the solar spectrum the radiation of maximum intensity is very far from the point where Herschel's observations seemed to place it. It is between D and E, at the wave-length 0·56μ. The violet and ultra-violet radiations present relatively considerable thermic intensities. The ultra-red portion is marked by four large known bands, the middle of which coincides with the wave-lengths 0·85μ, 0·985μ, 1·23μ, and 1·48μ. The spectrum is extinct at 1·98μ much sooner than that of the Bourbouze lamp.

Vibrations on the Surface of Liquids.—A mathematical paper, not capable of useful abstraction.

On the Magnet.—M. Trève.—An indefinite rectilinear current acting successively and in the manner of friction upon a bar of soft iron slightly magnetised can cause it to lose completely or to resume in part its original magnetisation.

Distillation of Liquids under the Influence of Static Electricity.—D. Gernez.—Under the influence of static electricity there is a passage of liquids from the positive to the negative region, and this distillation results in nowise from the unequal heating of the two liquid strata traversed by the electricity. The quantity of liquid transported is proportional to the quantity of electricity brought into play, and does not depend on the extent of the free surface of the liquid.

Non-existence of a Soluble Alcoholic Ferment.—D. Cochin.—The author's experiments tend to demonstrate that a soluble alcohol ferment does not exist, and that vegetation is a direct and immediate consequence of the life of the yeast-cells.

Solid Hydride of Cyanogen.—H. Lescœur and A. Rigaut.—This compound may be formed by adding a trace of melted potassium cyanide to pure anhydrous hydrocyanic acid. It forms crystals, which in percentage composition agree with hydrocyanic acid. They dissolve readily in acids and appear feebly basic.

Synthetic Methyl-propyl-carbinol.—J. A. Le Bel.—The author proposes to use low forms of vegetation, such as *Penicillium glaucum*, for the purpose of separating isomeric bodies.

Colouring Matter of Palmella cruenta.—T. L. Phipson.—The *Palmella cruenta* is a small alga much resembling clotted blood. Its colouring matter, *palmellin*, closely resembles hæmoglobin. It is, like the latter, insoluble in alcohol, ether, benzol, sulphide of carbon, &c., but it dissolves in water. It is, further, dichroic; it is composed of red matter united to an albuminoid substance, and is coagulated by alcohol, acetic acid, and by the application of heat. Like the colouring matter of blood it produces absorption-bands in the yellow part of the spectrum, though not exactly in the same position. Palmellin easily enters into putrefaction, giving off a strong ammoniacal odour, and, to complete its analogies with the colouring matter of blood, it contains iron.

MISCELLANEOUS.

British Association for the Advancement of Science.—The following are the names of the Officers and Committee of Section B (Chemical Science Section) of the Sheffield Meeting of the British Association:—

President.—Prof. Dewar, M.A., F.R.S. L. and E.

Vice-Presidents.—Prof. Abel, F.R.S.; Dr. Longstaff; Lowthian Bell, M.P.; W. Crookes, F.R.S.; Dr. J. H. Gladstone, F.R.S.; Dr. Gilbert, Ph.D., F.R.S.; A. Vernon Harcourt, M.A., F.R.S.; Prof. Odling, M.B., F.R.S.; Dr. Ronalds, F.R.S.E.; H. Clifton Sorby, F.R.S.; Prof. A. W. Williamson, F.R.S.

Secretaries.—W. Chandler Roberts, F.R.S.; J. Millar Thomson (Recorder); H. S. Bell, F.C.S.

Committee.—A. H. Allen, G. Ansdell, Prof. Attfield, Dr. Aug. Bernthsen, Dr. Campbell Brown, P. Braham, J. Y. Buchanan, F.R.S.E.; P. H. Carpenter, M.A.; M. P. de Clermont, J. H. Collins, W. Fairley, F.R.S.E.; A. Fletcher, Col. J. C. Gamble, W. Gimingham, G. Gladstone, W. N. Hartley, F.R.S.E.; A. K. Huntington, F. M. Jennings, Taiso Masaki, Prof. McLeod, E. Macadam, Dr. Morgan, Prof. Rowney, G. F. Schacht, M. R. D. Silva, Peter Spence, E. C. Stanford, W. Stoddard, W. Thomson, F.R.S.E.; R. C. Tichborne, Dr. Wm. Wallace, A. Wanklyn, R. Warington, W. Weldon, F.R.S.E.; E. J. Williams.

The papers brought before the Section were as follows:—

W. Chandler Roberts, F.R.S.—Report of Committee on the Chemistry of some of the lesser-known Alkaloids.

Walter Weldon, F.R.S.E.—On some relations between the numbers expressing the Atomic Weights of the Elements.

M. R. D. Silva.—On the Synthesis of Diphenyl-propyl.

F. A. Abel, F.R.S.—Recent Researches in Explosive Agents.

Prof. Dewar, F.R.S.—On Vapour-Densities.

P. Braham.—To Describe a large Crystal of Mercury Sulphate.

Henry S. Bell, F.C.S.—On the Manufacture of Crucible Steel.

Thomas Blair.—On the Separation of Iron and Phosphorus, especially with reference to the Manufacture of Steel.

John Hollway.—A New Process in Metallurgy.

A. H. Allen, F.C.S.—A Lecture Experiment in Illustration of the Hollway Process of Smelting Sulphide Ores.

Andrew French.—On Lead Fume, with a description of a New Process of Fume Condensing.

Prof. Odling, F.R.S.—On the Constitution of Aluminic Compounds.

A. H. Allen.—On the Presence of Nitrogen in Steel.

A. Vernon Harcourt, F.R.S.—Colour Tests for Phosphorus and Sulphur in Iron and Steel.

W. Chandler Roberts, F.R.S.—To Exhibit some Experiments with Hughes's Voltaic Induction Balance.

J. T. Brown.—Historical Sketch of the various Vapour-Density Methods.

Prof. Wanklyn.—Note on Certain Vapour-Densities.

Prof. Wanklyn.—Note on Isocyan-propionic Acid.

G. Ansdell.—Physical Constants of Liquid Acetylene and Hydrochloric Acid.

M. de Clermont.—The Action of Ammoniacal Salts on Metallic Sulphides.

W. Ivison Macadam.—On the Chemical Composition of a Nodule of Ozokerite found at Kinghorn-ness.

Thos. Andrews.—On some Curious Concretion Balls derived from a Colliery Mineral Water.

Dr. Gilbert, F.R.S.—On some points in connection with Agricultural Chemistry.

T. S. Humpidge, B.Sc.—On the rare Metals of the Yttrium Group.

Prof. Dewar, F.R.S.—On the Synthesis of Hydrocyanic Acid.

Prof. Dewar, F.R.S.—On the Amount of Nitrous Acid produced in Electric Illumination.

Prof. Dewar, F.R.S.—On the Kinoline Bases.

John M. Thomson.—An account of some Recent Experiments on Supersaturated Solutions.

J. Norman Lockyer, F.R.S.—Notes of some Recent Spectral Observations.

A. H. Allen.—Notes on Petroleum Spirit or Benzoline.

A. Vernon Harcourt, F.R.S.—On the Illuminative Value of a Mixture of Hydrogen.

G. T. Hazelhurst.—On a New Form of Condenser.

W. Thomson, F.R.S.E.—Notes on a Sample of Fuller's Earth found in an old Fullonica recently excavated at Pompeii.

W. H. Watson.—On the Detection of Milk Adulteration.

Dr. Phipson.—Chemical Researches on the *Palmella cruenta*.

Philip Braham.—Description of a Glass Burette for Collecting, Measuring, and Discharging Gas over Mercury.

TO CORRESPONDENTS.

J. M. Caren.—Metallic zinc is prepared by distillation and rapid condensation. It can be purchased cheaply.

Blue Blood.—In *Reimann's Färber Zeitung.*

THE CHEMICAL NEWS.

Vol. XL. No. 1032.

THE SUPPOSED COMPOUND NATURE OF THE ELEMENTS.*

By J. NORMAN LOCKYER, F.R.S., &c.

Continuing my researches into the nature of the so-called elements, I have found that when carefully distilled metallic sodium was condensed in a capillary tube, placed in a retort, and heated in a Sprengel vacuum it gave off twenty times its volume of hydrogen. Phosphorus, carefully dried and submitted to the same treatment, gave off 70 volumes of a gas which appeared to consist chiefly of hydrogen. Although it gave some of the lines of phosphorus it was not PH_3, as it had no action on solution of cupric sulphate. A specimen of magnesium carefully purified by Messrs. Johnson and Matthey, gave me a magnificent series of coloured phenomena. The hydrogen lines first appeared, then the D line—not the sodium line be it understood, for the green line was absent—and, lastly, the green line of magnesium (*b*), and then, as the temperature was increased, mixtures of all these lines, with the blue line, the D line being always the most brilliant. In this experiment only 2 volumes of hydrogen were collected. From gallium and arsenic no gas of any kind was obtained. From sulphur and some of its compounds sulphurous anhydride was always obtained. From indium hydrogen was given off *in vacuo* before heating, while from lithium no less than 100 volumes of hydrogen were given off. The conditions of the experiments were always the same, the only variable being the substance itself.

A LECTURE EXPERIMENT IN ILLUSTRATION OF THE HOLLWAY PROCESS OF SMELTING SULPHIDE ORES.*

By ALFRED H. ALLEN, F.I.C., F.C.S.

By causing oxygen gas to bubble through molten antimony sulphide contained in a V-shaped piece of combustion-tube, combustion takes place with such rise of temperature as to soften the glass, while a sublimate is obtained of antimonious iodide, and sulphurous acid gas is evolved. The sublimate is collected in an empty globe, and the sulphurous acid is absorbed by passing it into a large vessel containing lumps of wood-charcoal. At the conclusion of the experiment the contents of the combustion-tube may be poured out, when a button of metallic antimony free from sulphur is obtained.

By passing oxygen over lumps of pyrites contained in a heated combustion-tube, vivid combustion takes place, much free sulphur sublimes, and sulphurous acid gas is obtained and absorbed as before described.

NOTES ON PETROLEUM SPIRIT OR "BENZOLINE."*

By ALFRED H. ALLEN, F.I.C., F.C.S.

The application of the commercial names "benzoline" and "benzine" to the more volatile portion of petroleum has led to great confusion between petroleum spirit and coal-tar naphtha, the most characteristic constituent of which is the hydrocarbon *benzene* or *benzol*.

Although presenting close general resemblances, the following characteristic differences exist between petroleum spirit and coal-tar naphtha. All the tests given have been carefully verified by the author on representative samples of petroleum spirit and coal-tar benzol.

Petroleum Spirit, "Benzoline" or "Benzine."	*Coal-Tar Naphtha, or "Benzol."*
1. Consists of *heptane*, C_7H_{16}, and its homologues.	1. Consists of *benzene*, C_6H_6, and its homologues.
2. Heptane contains 84·0 per cent of carbon.	2. Benzene contains 92·3 per cent of carbon.
3. Commences to boil at 54° to 60° C.	3. Commences to boil at about 80° C.
4. Specific gravity at 15·5° C. about 0·69 to 0·72.	4. Specific gravity about 0·88.
5. Smells of petroleum.	5. Smells of coal-tar.
6. Dissolves iodine, forming a solution of a raspberry-red colour.	6. Dissolves iodine, forming a purple-red liquid of the tint of an aqueous solution of potassium permanganate.
7. Does not sensibly dissolve coal-tar pitch, and is scarcely coloured by it, even on prolonged contact.	7. Readily dissolves coal-tar pitch, forming a deep-brown solution.
8. When shaken in the cold, with one-third of its volume of fused crystals of absolute carbolic acid, the latter remains undissolved, and forms a separate lower stratum.	8. Miscible with absolute carbolic acid in all proportions.
9. Requires two volumes of absolute alcohol, or four or five volumes of methylated spirit of 0·828 sp. gr., for complete solution at the ordinary temperature.	9. Miscible with absolute alcohol in all proportions. Forms a homogeneous liquid with an equal measure of methylated spirit of 0·828 sp. gr.
10. Warmed with four measures of nitric acid of 1·45 sp. gr. the acid is coloured brown, but the spirit is little acted on, and forms an upper layer.	10. Completely miscible with four measures of nitric acid of 1·45 sp. gr., with great rise of temperature and production of dark brown colour. A portion of the nitrobenzene produced may separate as the liquid cools.

The greater number of the above tests are valueless when applied to mixtures of petroleum and coal-tar naphthas, but No. 10 is capable of giving quantitative results if the treatment with nitric acid be conducted in a small flask and an inverted condenser attached, to prevent loss of vapours. When action has nearly ceased, if the liquid be poured into a narrow graduated tube, the measure of the upper layer indicates with approximate accuracy the amount of petroleum spirit present. If the proportion of benzene is considerable, the nitrobenzene produced may not remain completely dissolved in the nitric acid, in which case it rises and forms a layer of a dark brown colour below the stratum of petroleum spirit. Nitrobenzene and petroleum spirit are readily miscible in the absence of nitric acid, but agitation with strong nitric acid dissolves out the nitrobenzene, a portion of which may rise and form an intermediate layer as above described.

By fractional distillation, the author found that the

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* Read before the British Association for the Advancement of Science, (Section B.), Sheffield, 1879.

proportion of *heptane*, C_7H_{16}, present in commercial benzoline probably equalled, or even exceeded, that of all the other constituents.

ON THE DETECTION OF MILK ADULTERATION.*

By WILLIAM H. WATSON, F.C.S., &c.

From analyses of milk from various dairies, and by a comparison of the results obtained with circumstances existing as to the character and quantity of the food; nature of different cows; conditions and health of them at particular periods; and changes of the seasons of the year, the author concludes that cows' milk is subject to considerable variations in composition. He has found in many instances milk from well-fed healthy cows to contain as little as 10·5 per cent of total solids, and from 8·5 to 9 per cent of solids not fat. The results of other experimenters are compared, and it is then suggested that the present limits adopted by public analysts for genuine milk should be re-considered.

ON THE MANUFACTURE OF CRUCIBLE STEEL.*

By HENRY S. BELL, F.C.S., &c.

The manufacture of crucible steel is one of the most important industries connected with the town of Sheffield, which boasts of not less than 120 firms engaged in the production of this material. Notwithstanding the enormous output of steel by the Bessemer and Siemens-Martin processes, this kind of steel is unrivalled for the manufacture of the finer varieties of cutlery and edged tools, &c. A brief outline of the process itself is as follows:—The most of the iron employed for this purpose is imported into this country in the shape of bars, from Sweden, where it has been smelted from very pure iron ores, in a blast-furnace, by the aid of charcoal, and subsequently puddled to free it from impurities.

The first operation to which it is subjected is that known as the cementation or converting process, the object of which is to combine a certain quantity of carbon with the iron; this operation is performed in a furnace of peculiar construction, where the iron and charcoal are packed together in air-tight chests or converting pots, subjected to a high temperature short of the fusing-point of iron, where it remains for a matter of three weeks.

After the conversion, when the pots are cold the bars are taken out and found to be covered with blisters; hence it is termed Blister Steel. In consequence of the various theories proposed to account for this peculiar formation, the writer was induced to make a series of investigations. For this purpose he was kindly furnished by Messrs. Seebohm and Dieckstahl, of the Dannemora Steel Works, with some samples of this blister steel, various portions of which he submitted to analysis, the results of which showed a marked increase of silicon where the blisters occurred, thus—

			Per cent Silicon.
Sample	1.	Blister 2 ins. in length contained..	0·070
,,	2.	Small blister contained	0·048
,,	3.	,, ,, ...	0·056
,,	1.	Unblistered portions contained ..	0·023
,,	2.	,, ,, ...	0·021
,,	3.	,, ,, ...	0·025

On inspecting one of these bars of blister steel, it is found that it has undergone both a physical and a chemical change.

The iron has now assumed a crystalline structure, and has chemically combined with a certain amount of carbon. This latter change commences on the exterior, and extends itself to the interior of the bar, if the process be continued sufficiently long, thus showing that carbonic oxide never penetrates into the centre of the bar, until the whole is converted into steel.

The writer is indebted to the kindness of the above-mentioned firm for a sample of bar iron, before and after conversion, in order to ascertain the exact chemical change that took place during the process. The following are the results obtained:—

	Before Conversion.	After Conversion.
Fe	99·471	98·603
C	0·352	1·250
Si	0·050	0·035
S	0·027	0·022
P	0·025	0·018
Mu	0·075	0·072
	100·000	100·000

The decrease in impurities appears greater than it really is, owing to the fact that the bar itself has increased in weight by the addition of carbon.

One remarkable fact is that, after the conversion of the iron, a quantity of the charcoal, in the converting pots, is found in a pulverised state, so as to be unfit for further use.

Some of this waste charcoal the writer has examined, and from one sample, by the aid of a magnet, he succeeded in extracting 5 to 6 per cent of iron scale and small pieces of steel. These on being treated with dilute hydrochloric acid, evolved considerable quantities of sulphuretted hydrogen; in one case he estimated the quantity of sulphur, and found it to contain as much as 1·25 per cent of this element. The blister steel thus produced, for the sake of convenience is divided into six different classes, viz.

Spring heat.
Single shear heat.
Steel through heat.
Country heat.
Double shear heat.
Melting heat.

The steel is now broken up into small pieces and melted in crucibles, and cast into ingots. These are sent to the forge, where they are heated and rolled. In this part of the process the chief difficulty with which the tilter has to contend is the porous or "honey-combed" structure of the steel.

One of the characteristic features relied on by practical men as indicating the quality of a piece of steel is the appearance of its fracture; but this is by no means an infallible test, as the fineness or coarseness of grain can be produced by mechanical treatment or chemical means.

The characteristic property possessed by steel is its capability of being hardened and tempered. The temper of cast steel may be said to range from 0·75 to 1·50 per cent carbon. The temper of steel is an important question in connection with the purpose for which it is required: thus a steel containing 1·50 per cent of carbon is the class employed for razors; 1·25 per cent is that known as "tool temper;" steel containing 1·00 per cent carbon is termed "chisel steel," and this temper is extensively used in the arts.

The favourite marks of Swedish non-employed in the manufacture of this kind of steel, are those obtained from Dannemora, the most noted of which are the 00 = Double Bullet,—

G_{L} = GL, and Ⓛ = Hoop L.

The most important of the elements which affect the quality and mechanical properties of steel are the following:—

Carbon, Silicon, Sulphur, Phosphorus, and Manganese.

Carbon, by its direct combination with iron, is essentially

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* Abstract of a paper read before the British Association for the Advancement of Science (Section B.), Sheffield, 1879.

the steel-forming element, and greatly increases the hardness and tensile strength of the metal. The maximum quantity of carbon capable of being taken up by iron is 6·5 per cent to 7·00 per cent. This high percentage of carbon is only attained, as in the case of rich ferromanganese, containing as much as from 85 to 86 per cent of manganese.

Silicon.—The action of this element on steel is to produce both red- and cold-shortness, especially in high made steels. Under certain conditions, it is capable of imparting hardness without brittleness. The presence of this element also tends to favour a solid casting, and prevent the formation of a honey-combed structure.

Sulphur in steel, as is well known, produces "red-shortness," and has also a tendency to prevent the chemical combination of iron with carbon, and also to displace it when in combination.

Phosphorus produces cold-shortness and brittleness, but the detrimental influence of this element, when present only in small quantities, can be partially neutralised, providing the percentage of carbon is very low.

Manganese is a valuable ally of the steel melter, and serves to correct the evil effects produced by the presence of sulphur, oxygen, &c.; and when in the state of an oxide serves to eliminate a large percentage of the silicon.

Manganese is generally introduced into the steel in the form of "Spiegeleisen," an alloy of iron, carbon, and manganese, generally containing about 10 per cent of the latter element.

Other metals have been employed to replace carbon, such as tungsten, chromium, and titanium; these impart great hardness and fineness to the texture of steel.

For a considerable amount of practical information given in his paper, but necessarily omitted from this abstract, the writer is indebted to a valuable essay written some years ago on this subject by Henry Seebohm, of the firm of Messrs. Seebohm and Dieckstahl.

This paper is not intended to give any additional information to the practical steel makers of Sheffield, as to the manufacture of steel, or to offer any criticisms or advice in the matter; its object is simply to give an outline of the manufacture as it is still carried on in this town, with the hope that it may prove interesting to many of those who have come from a distance to attend the visit of the British Association, and who are unacquainted with the process which has caused Sheffield to become the great manufacturing steel centre in this country.

ON SOME CURIOUS CONCRETION BALLS DERIVED FROM A COLLIERY MINERAL WATER.[*]

By THOMAS ANDREWS, F.C.S.

The water on which these observations were made was collected from the "sump" of the Wortley Silkstone Colliery, a small pit situated near the "Bassett" or "outcrop" of the great Silkstone seam of coal; the samples being obtained during typical *dry* and *rainy* seasons. The water had percolated from the surface a distance of 35 yards, through strata, as indicated on the accompanying table.

The bottom layer in which the water lodged was the Silkstone seam of coal, here some 5 feet in thickness.

One noticeable feature of this water is, that it always gives an acid reaction with blue litmus paper.

Several analyses of this water made at various times indicate that the chief mineral constituents of the water are, iron—calcium, magnesium, in the form of sulphates.

This water when heated quickly throws down a copious ochreous deposit. The deposit found in the engine boilers after having used the water in them for steam purposes was of the composition given below.

The boiler residue from which this sample was taken consisted of an incrustation about *one inch* thick, which had adhered to the bottom of the boiler.

The incrustation was of a light reddish yellow colour in the bulk, it was very hard and tough, and not easily broken in pieces.

The iron work in connection with this colliery engine and boilers, in any way exposed to the action of either the acid water itself, or *the steam generated from it*, becomes corroded and partially dissolved. The most effectual remedy against this corrosive action and deposit, is that described in my letter to the Chemical News, vol. xxxv., p. 252.

Analysis of Boiler Deposit, from Wortley Silkstone Colliery Boilers, September 15, 1875.

Moisture	6·85	per cent.
Combined water, organic matter, &c. ..	5·80	,,
Silicious matter	1·80	,,
Peroxide or iron and alumina containing phosphoric acid 0·76 per cent	6·10	,,
Sulphate of lime..	78·55	,,
Magnesia	0·65	,,
	99·75	,,

Some curious balls of mineral matter are occasionally found in the feed tank of the colliery boilers, which are supplied with this water. The water is pumped up from the engine pond into a cylindrical feed tank, and is there heated by the exhaust steam from the engine playing on its surface (not blowing through it). The water in this feed tank has an average temperature of 164° F.

It sometimes happens that during the short space of even two or three weeks, great numbers of these balls are formed, varying in size from about 3½ inches in diameter to ⅝ inch diameter, and in weight from about one and a half pounds to a quarter of an ounce.

The author has many of these in his possession. They are perfectly hard and compact when taken from the tank, and are no doubt formed from the deposit thrown down when the mineral water is heated.

The action of steam playing on the surface of the water probably causes circular eddies, and when a nucleus has thus once been formed, it is easy to conceive of the gradual formation and consolidation of these balls.

The author suggests that the conditions of formation of natural nodules of iron ore, pyrolusite, &c., may be similar to those observed by him in the foregoing cases.

The following is the analysis of the balls formed in the feed tank, from which it will be seen that they are quite different in composition to the residue deposited in the boilers, owing probably to the difference in the temperature between the feed tank and the boiler.

Analysis of a Concretion Ball, found in the Engine Feed Tank, Wortley Silkstone Colliery.

Moisture	2·30	per cent.
Loss on ignition, organic matter, &c., contains matters extracted by ether, 5·8 per cent	24·40	,,
Silica	1·80	,,
Peroxide of iron	62·86	,,
Alumina	5·43	,,
Phosphoric acid	2·81	,,
Lime	0·40	,,
Magnesia	trace	
	100·00	,,

They also differ in composition from concretions deposited at the pit bottom in the cold, which show only 45·71 per cent of Fe_2O_3.

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[*] Read before the British Association for the Advancement of Science (Section B.), Sheffield, 1879.

Observations made to ascertain the Temperature at which the Deposit and Turbidity take place.

Temperature at which Turbidity Commences.

	Dry Season.	Wet Seasons.
Average of four observations ..	147° F.	160·5° F.

The action of this mineral water is destructive to all iron work with which it comes in contact. The amount of iron dissolved by samples of the water in the cold being as follows :—

July, 1868.—7000 fluid grains = 1 lb. of the water dissolved 1·85 grain of iron during one month.

Feb., 1876.—3500 fluid grains = ½ lb. of the water (collected during a *dry season*) dissolved 2·91 grains of iron in eight months.

July, 1876.—3·500 fluid grains = ½ lb. of the water (collected during a *dry season*) dissolved 4·73 grains of iron in eight months.

Reaction of the water with litmus at the conclusion of these experiments only *faintly* acid.

Quantities of iron pyrites are found in the coal strata of this neighbourhood, and account for the large quantities of sulphates often found in these colliery waters.

The water during *flood seasons* required (as an average of five determinations) an addition of 10·48 grains of anhydrous Na_2O per gallon, before an alkaline reaction was obtainable, and during *dry seasons* (as an average of three determinations) an addition of 17·35 grains of anhydrous Na_2O per gallon. This amount of alkali does not all correspond to free acid, as the sulphate of iron would also neutralise soda.

Determinations of the Total Inorganic Constituents were made at the dates and with the results as below. Results in grains per gallon.

Date.	Total amount of Inorganic Matters.	
June 20, 1865..	56·20	
October 12, 1867	66·60	
July 27, 1868	67·60	(Very dry season)
June 25, 1874..	133·70	(Very dry season)
June 27, 1874..	198·80	

The sulphates, a very important element in the composition of this water, were determined as per following results. An average of six estimations of the total sulphates (results calculated as SO_3), extending from 1865 to 1876, made during—

Dry seasons—giving 115·41 grains per gallon of SO_3.

An average of eight estimations, extending over the same period of time, but made during—

Rainy seasons—gave 67·62 grains per gallon of SO_3.

A fact worthy of notice in course of these analyses is the steady and large increase in the amount of the sulphates, from the commencement of these observations in 1865 to 1876.

The same result is also noticeable on reference to the total amounts of inorganic matter, which show a great increase in quantity during the latter part of the time.

Now why this increase in the total sulphates and total matters in solution should take place it is not easy to say. It may be owing to the fact of the increased length and area of the workings in the colliery, as undoubtedly there is more bulk of water to contend with now than formerly on this account; but why the mineral matter in the water should have increased owing simply to this increase in quantity is not at first sight very clear.

It may be possible that the largely increased number, area, and length of air-ways has a tendency to expose the water for a longer time to oxidising influences, and thus add to the percentage of sulphates, and this increased facility for oxidation no doubt also induces more rapid solution of the strata as the water slowly permeates through it.

The author hopes these few imperfect observations may not prove altogether uninteresting to those who take pleasure in the study of mineral waters.

ON RADIANT MATTER.*

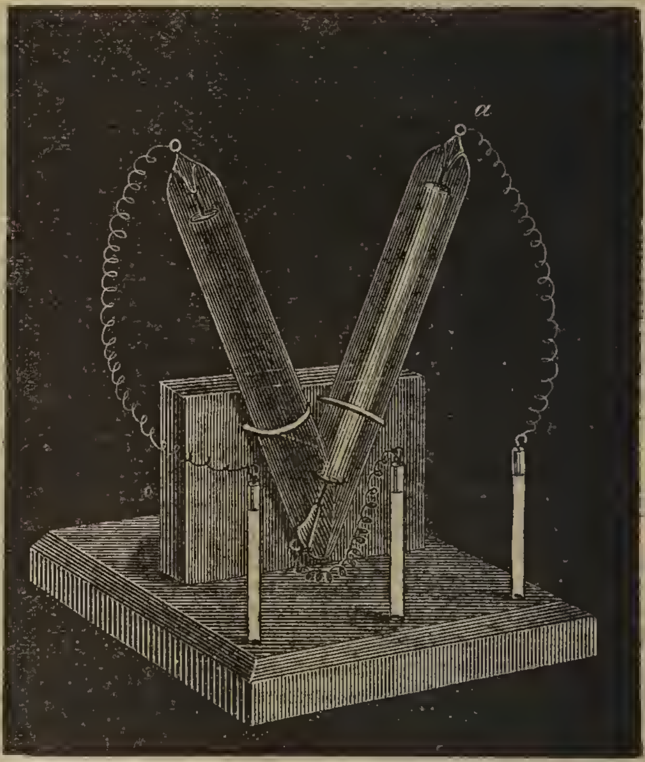
By WILLIAM CROOKES, F.R.S.

(Continued from page 93.)

Radiant Matter proceeds in straight lines.

The Radiant Matter whose impact on the glass causes an evolution of light, absolutely refuses to turn a corner. Here is a V-shaped tube (Fig. 6), a pole being at each extremity. The pole at the right side (*a*) being negative, you see that the whole of the right arm is flooded with green light, but at the bottom it stops sharply and will not turn the corner to get into the left side. When I reverse the current and make the left pole negative, the green changes to the left side, always following the negative pole and leaving the positive side with scarcely any luminosity.

Fig. 6.



In the ordinary phenomena exhibited by vacuum tubes —phenomena with which we are all familiar—it is customary, in order to bring out the striking contrasts of colour, to bend the tubes into very elaborate designs. The luminosity caused by the phosphorescence of the residual gas follows all the convolutions into which skilful glass-blowers can manage to twist the glass. The negative pole being at one end and the positive pole at the other, the luminous phenomena seem to depend more on the positive than on the negative at the ordinary exhaustion hitherto used to get the best phenomena of vacuum tubes. But at a very high exhaustion the phenomena noticed in ordinary vacuum tubes when the induction spark passes through them—an appearance of cloudy luminosity and of stratifications—disappear entirely. No cloud or fog whatever is seen in the body of the tube, and with such a vacuum as I am working with in these experiments, the only light observed is that from the phosphorescent surface of the glass. I have here two bulbs (Fig. 7), alike in shape and position of poles, the only difference being that one is at an exhaustion equal to a few millimetres of mercury—such a moderate exhaustion as will give the ordinary luminous phenomena—whilst the other is exhausted to about the millionth of an atmosphere. I will first connect the mode-

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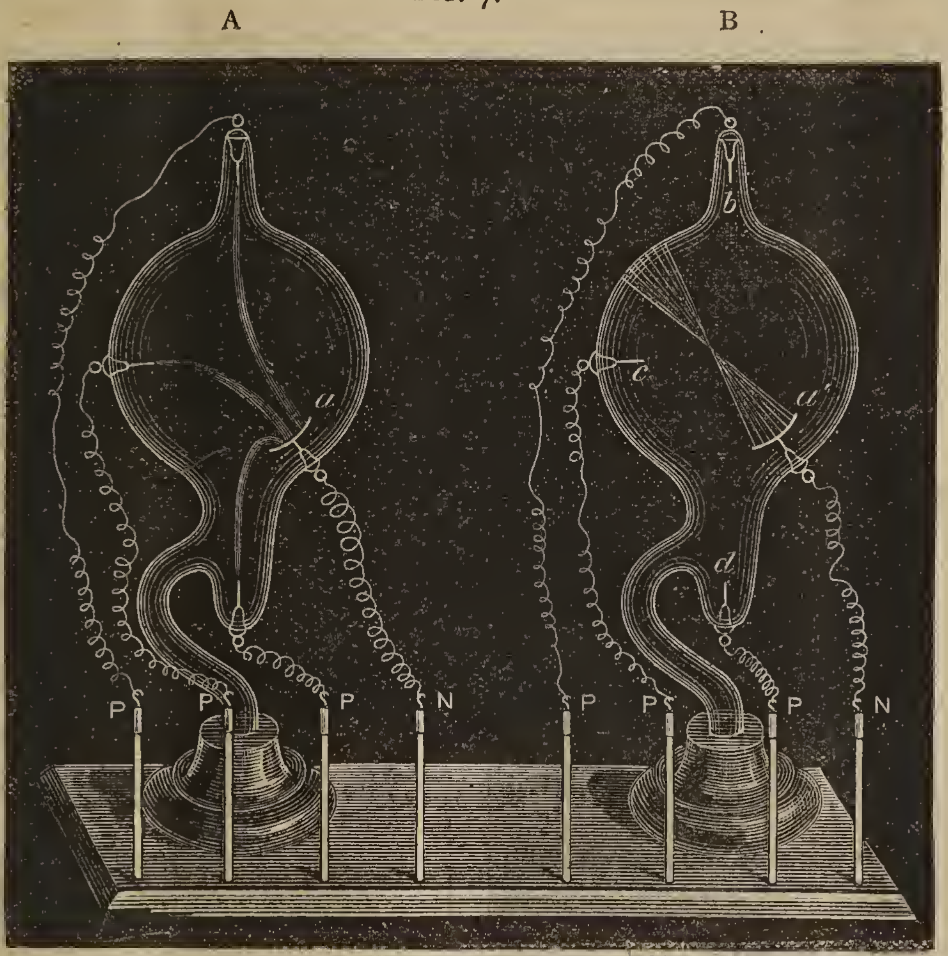
* A Lecture delivered to the British Association for the Advancement of Science, at Sheffield, Friday, August 22, 1879

rately exhausted bulb (A) with the induction-coil, and retaining the pole at one side (*a*) always negative, I will put the positive wire successively to the other poles with which the bulb is furnished. You see that as I change the position of the positive pole, the line of violet light joining the two poles changes, the electric current always choosing the shortest path between the two poles, and moving about the bulb as I alter the position of the wires.

Fig. 7.



This, then, is the kind of phenomenon we get in ordinary exhaustions. I will now try the same experiment with a bulb (B) that is very highly exhausted, and as before, will make the side pole (*a'*) the negative, the top pole (*b*) being positive. Notice how widely different is the appearance from that shown by the last bulb. The negative pole is in the form of a shallow cup. The molecular rays from the cup cross in the centre of the bulb, and thence diverging, fall on the opposite side and produce a circular patch of green phosphorescent light. As I turn the bulb round you will all be able to see the green patch on the glass. Now observe, I remove the positive wire from the top, and connect it with the side pole (*c*). The green patch from the divergent negative focus is there still. I now make the lowest pole (*d*) positive, and the green patch remains where it was at first, unchanged in position or intensity.

We have here another property of Radiant Matter. In the low vacuum the position of the positive pole is of every importance, whilst in a high vacuum the position of the positive pole scarcely matters at all; the phenomena seem to depend entirely on the negative pole. If the negative pole points in the direction of the positive, all very well, but if the negative pole is entirely in the opposite direction it is of little consequence: the Radiant Matter darts all the same in a straight line from the negative.

Fig. 8.

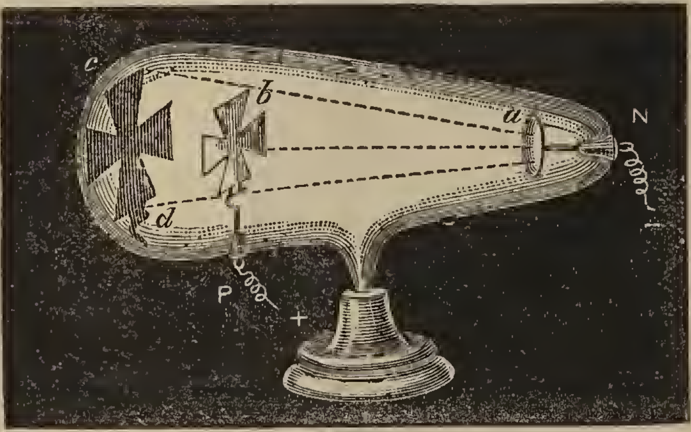
If, instead of a flat disk, a hemi-cylinder is used for the negative pole, the Matter still radiates normal to its surface. The tube before you (Fig. 8) illustrates this property. It contains, as a negative pole, a hemi-cylinder (*a*) of polished aluminium. This is connected with a fine copper wire, *b*, ending at the platinum terminal, *c*. At the upper end of the tube is another terminal, *d*. The induction-coil is connected so that the hemi-cylinder is negative and the upper pole positive, and when exhausted to a sufficient extent the projection of the molecular rays to a focus is very beautifully shown. The rays of Matter being driven from the hemi-cylinder in a direction normal to its surface, come to a focus and then diverge, tracing their path in brilliant green phosphorescence on the surface of the glass.

Instead of receiving the molecular rays on the glass, I will show you another tube in which the focus falls on a phosphorescent screen. See how brilliantly the lines of discharge shine out, and how intensely the focal point is illuminated, lighting up the table.

Radiant Matter when intercepted by solid matter casts a shadow.

Radiant Matter comes from the pole in straight lines, and does not merely permeate all parts of the tube and fill it with light, as would be the case were the exhaustion less good. Where there is nothing in the way the rays strike the screen and produce phosphorescence, and where solid matter intervenes they are obstructed by it, and a shadow is thrown on the screen. In this pear-shaped bulb (Fig. 9) the negative pole (*a*) is at the pointed end.

Fig. 9.



In the middle is a cross (*b*) cut out of sheet aluminium, so that the rays from the negative pole projected along the tube will be partly intercepted by the aluminium cross, and will project an image of it on the hemispherical end of the tube which is phosphorescent. I turn on the coil, and you will all see the black shadow of the cross on the luminous end of the bulb (*c*, *d*). Now, the Radiant Matter from the negative pole has been passing by the side of the aluminium cross to produce the shadow; the glass has been hammered and bombarded till it is appreciably warm, and at the same time another effect has been produced on the glass—its sensibility has been deadened. The glass has got tired, if I may use the expression, by the enforced phosphorescence. A change has been produced by this molecular bombardment which will prevent the glass from responding easily to additional excitement; but the part that the shadow has fallen on is not tired—it has not been phosphorescing at all and is perfectly fresh; therefore if I throw down this cross,—I can easily do so by giving the apparatus a slight jerk, for it has been most ingeniously constructed with a hinge by Mr. Gimingham,—and so allow the rays from the negative pole to fall uninterruptedly on to the end of the bulb, you will suddenly see the black cross (*c*, *d*, Fig. 10) change to a luminous one (*e*, *f*), because the background is now only capable of faintly phosphorescing, whilst the part which had the black shadow on it retains its full phosphorescent power. The stencilled image of the luminous cross unfortunately soon dies out. After a period of rest the glass partly recovers its power of phosphorescing, but it is never so good as it was at first.

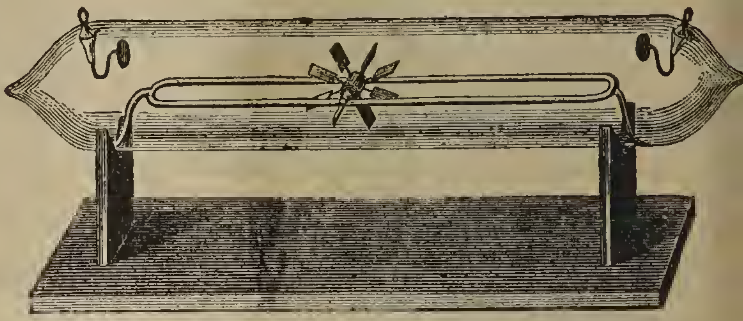
Fig. 10.

Here, therefore, is another important property of Radiant Matter. It is projected with great velocity from the negative pole, and not only strikes the glass in such a way as to cause it to vibrate and become temporarily luminous while the discharge is going on, but the molecules hammer away with sufficient energy to produce a permanent impression upon the glass.

Radiant Matter exerts strong mechanical action where it strikes.

We have seen, from the sharpness of the molecular shadows, that Radiant Matter is arrested by solid matter placed in its path. If this solid body is easily moved the impact of the molecules will reveal itself in strong mechanical action. Mr. Gimingham has constructed for me an ingenious piece of apparatus which when placed in the electric lantern will render this mechanical action visible to all present. It consists of a highly exhausted glass tube (Fig. 11), having a little glass railway running along it from one end to the other. The axle of a small wheel revolves on the rails, the spokes of the wheel carrying wide mica paddles. At each end of the tube, and rather above the centre, is an aluminium pole, so that whichever pole is made negative the stream of Radiant Matter darts from it along the tube, and striking the upper vanes of the little paddle-wheel causes it to turn round and travel along the railway. By reversing the poles I can arrest the wheel and send it the reverse way, and if I gently incline the tube the force of impact is observed to be sufficient even to drive the wheel up-hill.

Fig. 11.



This experiment therefore shows that the molecular stream from the negative pole is able to move any light object in front of it.

The molecules being driven violently from the pole there should be a recoil of the pole from the molecules, and by arranging an apparatus so as to have the negative pole movable aad the body receiving the impact of the Radiant Matter fixed, this recoil can be rendered sensible. In appearance the apparatus (Fig. 12) is not unlike an ordinary radiometer with aluminium disks for vanes, each disk coated on one side with a film of mica. The fly is supported by a hard steel instead of glass cup, and the needle point on which it works is connected by means of a wire with a platinum terminal sealed into the glass. At the top of the radiometer bulb a second terminal is sealed in. The radiometer therefore can be connected with an induction-coil, the movable fly being made the negative pole.

For these mechanical effects the exhaustion need not be so high as when phosphorescence is produced. The best pressure for this electrical radiometer is a little beyond that at which the dark space round the negative pole extends to the sides of the glass bulb. When the pressure is only a few millims. of mercury, on passing the induction current a halo of velvety violet light forms on the metallic side of the vanes, the mica side remaining dark. As the pressure diminishes, a dark space is seen to separate the violet halo from the metal. At a pressure of half a millim. this dark space extends to the glass, and rotation commences. On continuing the exhaustion the dark space further widens out and appears to flatten itself against the glass, when the rotation becomes very rapid.

Fig. 12.

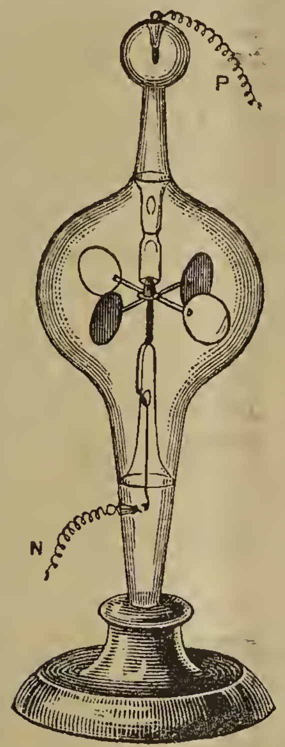
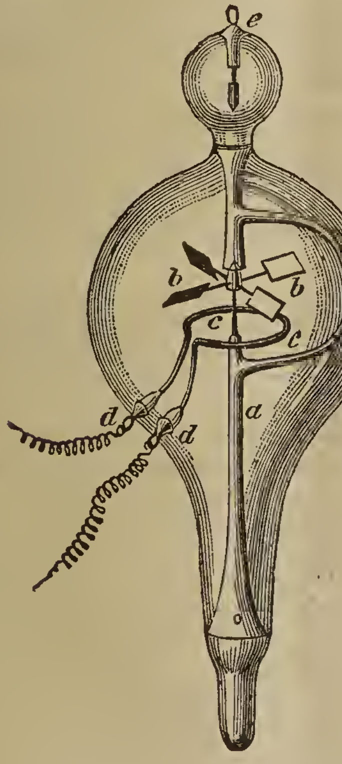


Fig. 13.



Here is another piece of apparatus (Fig. 13) which illustrates the mechanical force of the Radiant Matter from the negative pole. A stem (*a*) carries a needle-point in which revolves a light mica fly (*b b*). The fly consists of four square vanes of thin clear mica, supported on light aluminium arms, and in the centre is a small glass cap which rests on the needle-point. The vanes are inclined at an angle of 45° to the horizontal plane. Below the fly is a ring of fine platinum wire (*c c*), the ends of which pass through the glass at *d d*. An aluminium terminal (*e*) is sealed in at the top of the tube, and the whole is exhausted to a very high point.

By means of the electric lantern I project an image of the vanes of the screen. Wires from the induction-coil are attached, so that the platinum ring is made the negative pole, the aluminium wire (*e*) being positive. Instantly, owing to the projection of Radiant Matter from the platinum ring, the vanes rotate with extreme velocity. Thus far the apparatus has shown nothing more than the previous experiments have prepared us to expect; but observe what now happens. I disconnect the induction-coil altogether, and connect the two ends of the platinum wire with a small galvanic battery; this makes the ring *cc* red-hot, and under this influence you see that the vanes spin as fast as they did when the induction-coil was at work.

Here, then, is another most important fact. Radiant Matter in these high vacua is not only excited by the negative pole of an induction-coil, but a hot wire will set it in motion with force sufficient to drive round the sloping vanes.

(To be continued.)

NEW PROCESS FOR THE RAPID ESTIMATION OF PURE SUGAR IN RAW AND REFINED COMMERCIAL SUGARS.*

By P. CASAMAJOR.

(Continued from page 98.)

After trying many experiments with solutions of different strengths, it was found that each solution required a different weight. For the saturated solution of 77·1° of the alcohometer, which is our standard solution, the weight is 39·6 grms. for 100 c.c. of the solution.

Instead of using 100 c.c., I have, for a long time, used only 50. To be able to use a cylinder in which this volume would give indications, I needed to use alcohometers of quite small diameter. These were made by Mr. H. Weinhagen; they are very well graduated and very satisfactory in every way.

For 50 c.c. of standard solution, the proper weight is half of the one for 100 c.c. = 19·8 grms. To show how this was obtained, the following table, No. 2. is given. In the first column are numbers designating the sugars that were tested; in the second column is the percentage of sugar as obtained by the optical saccharometer; in the third column is the result by the methylic alcohol process, when we take 19 grms. as the weight of the sugar tested; in the fourth column is the quantity that should have been taken, instead of 19 grms., to obtain the same result as by the optical saccharometer. These weights were obtained by the calculation already given.

Table No. 2.

Sugar.	Degree of saccharometer.	Result by methylic alcohol. Weight, 19 gr.	Weight to give results in 2nd col. gr.
1	91·6	91·9	19·7
2	84·8	85·36	19·66
3	91·7	92·1	19·96
4	81·7	82·46	19·8
5	88·8	89·1	19·7
6	96·3	96·6	20·6

From the results in the 4th column, the weight adopted was 19·8 gr.

By using this weight, with 50 c.c. of standard solution the following results were obtained in the case of 15 consecutive tests of raw and refined sugars:—

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* Read before the American Chemical Society, June 5, 1879.

TABLE NO. 3.

Designation of the sugar.	Percentage of pure sugar by saccharometer.	Ditto by methylic alcohol.	Difference.
Muscavado	82·4	82·3	−0·1
"	91·5	91·7	0·2
Refined	95·0	95·1	0·1
Molasses	86·5	87·2	0·7
Centrifugal	96·5	96·2	−0·3
Refined	96·3	96·6	0·3
"	92·3	92·1	−0·2
"	91·3	90·9	−0·4
"	84·4	83·7	−0·7
"	91·6	91·5	−0·1
"	84·8	84·7	−0·1
Raw	91·7	91·8	0·1
Refined	81·7	81·7	0·0
Muscavado	88·7	88·7	0·0
Centrifugal	96·3	96·5	0·2

The greatest deviation shown in this table is in the case of two sugars, in which the difference is 0·7. This is not due to impurities affecting the saccharometer, as I found by inverting the solution of the sugar in each case. In one of the sugars I found quite a number of soft lumps, which showed that the sugar was very uneven. In the other sugar nothing was found to account for the discrepancy.

The alcohometers used in these tests are those of Tralles, which are used by the United States Government. These do not differ materially from those of Gay-Lussac. They are more apt to differ from one another on account of defective construction, than they should do from Gay-Lussac's instrument.

Alcohometers, like other areometers, are very unreliable, unless placed in the hands of those who understand their use. We may, however, use alcohometers that are not strictly accurate, if only the divisions of the scale bear to one another the proper proportion, and if the displacement of the scale is not too great. This does not apply to the preparation of the standard solution, which should stand correctly at 77·1, which degree of the alcohometer of Tralles corresponds to specific gravity 0·87.

When we use an alcohometer that is properly graduated, and we have the standard solution standing at 77·1, we should add 22·9 to the degree of the alcohometer at 15° C., to obtain the percentage of sugar. If the alcohometer, through being defective, should not stand at 77·1 for 0·87 specific gravity, but at 76·5, the difference between this latter number and 100, being 23·5, this is the number to be added to the reading of the areometer at 15° C., to obtain the percentage of sugar in the sample under examination.

I have said that cane sugars of all grades, from the highest to the lowest, have given satisfactory results by this process. This assertion is borne out by the examples in table No. 3. I wish, however, to call attention to this, that I do comprise, under the head of sugars, melados or molasses. As to melados, those that have drained out and are comparatively dry may be classed as sugars, but wet melados give very poor results. This may be very easily understood if we remember what was said of the action of water in lowering the alcohometric degree of a saturated solution, as exemplified in table No. 1. I have little doubt, however, that by experimenting with saturated solutions of methylic hydrated of higher alcoholic degree, we may obtain a solution specially adapted for testing wet melados. It might even be possible, with methylic hydrate of still higher alcohometric degree, to test molasses within certain limits of density. As an operator can always tell beforehand whether what he has to test is properly a sugar, a wet melado, or a sample of molasses, he could always use the standard solution which was the best adapted to his sample.*

From past experience, with saturated solutions of various strengths, I may venture the opinion that methylic alcohol of 87° of the alcohometer, saturated with sugar, would make a good standard solution for wet melados. For molasses of density, about 40° B., methylic alcohol of 90½° (alcohometer), saturated with sugar, would not, as far as I can judge without trying it, be far from the proper strength. These are merely hints thrown out to chemists who are interested in testing sugar. Should I not work out these suggestions, I hope that others may find time to study them. The advantages of a process that allows a commercial saccharine product to be tested in about five minutes, are too great to be neglected. The weights of melados or molasses to be taken, would have to be determined, as was done for the weight 19·8 grms., as shown in table No. 2.

(To be continued.)

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 7.

Action of Antimony Trichloride and Tin Tetrachloride upon Naphthalin and other Aromatic Hydrocarbons.—Watson Smith.—In this preliminary communication the author states that he obtains a compound in which the chlorine of antimony trichloride is completely replaced either by three naphthalin residues or by a naphthalin residue and an atom of oxygen. He did not succeed in obtaining this substance in quantity.

Examination of an Aniline Residue.—C. Hell and P. Schoop.—The solid portion of the residue consisted of para-toluylen-diamin. The liquid portion is likewise to a great extent composed of toluylen-diamin, either in a new modification or rendered incapable of crystallising by the presence of isomers.

Addition Products of Acetic Acid with Bromine and Hydrobromic Acid.—C. Hell and O. Mühlhäuser.—The authors have confirmed their results formerly communicated, and determined the boundaries within which the combinations of acetic acid, bromine, and hydrobromic acid are possible.

An Addition Product of Acetic Acid with Bromine and Hydrochloric Acid, and the Power of Acetic Acid to Absorb Bromine and Hydrochloric Acid.—C. Hell and O. Mühlhäuser.—An appendix to the foregoing paper.

Action of Bromine upon Acetic Acid.—C. Hell and O. Mühlhäuser.—The quantities of hydrobromic acid formed increase in geometrical progression up to the formation of a crystalline addition product.

Chloral Hydrate.—A. Naumann.—The author endeavours to prove the resolution of this compound into chloral and water by fractional distillation, and examining the composition of the distillates and the residues.

Specific Heat of Urano-uranic Oxide and the Atomic Weight of Uranium.—Julius Donath.—The average of four determinations of the specific heat of this

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* With melados and molasses, as well as with very low sugars, the direct test seldom gives the true percentage of sugar. It is neccessary to invert, to obtain the correct result, and when we invert a solution that has been imperfectly decolorised, it becomes so red, after inversion, that it is a difficult matter to see through the tube. With chloride of tin and filtration over bone-black, it is possible to improve the colour of the solutions, but even these often fail. The bone-black should be dry and not too great a quantity should be used. On account of these difficulties with dark solutions, experiments to establish the strength of the standard solution and the weight of sugar may have to be made entirely with refined syrups or with low grade refined sugars, to which 5 or 6 per cent additional of water should be added.

compound is 0·07979. The atomic weight of uranium is 120 and the atomic heat 5·96.

Preparation of Barium from Barium Amalgam.—Julius Donath.—The author criticises the methods proposed by Crookes, Bunsen, and S. Kern, and considers that the metal thus obtained is in all cases contaminated with mercury, pure barium being only obtained electrolytically.

Oxidation of Chinolin by Potassium Permanganate.—S. Hoogewerff and W. A. van Dorp.—The authors obtain by this reaction dicarbopyridic acid, thus confirming the view of a close connection between chinolin and pyridin.

Preparation of Mono- and Di-substituted Organic Malonic Acids.—M. Conrad.—Not susceptible of useful abstraction.

Possibility of enabling Chloro-phyllaceous Plants not known as Saprophytic or Parasitical, to Dispense with the Carbonic Acid of the Air by Means of a Supply of Organic Matter.—M. Schmœger.—Stutzer has answered this question in the affirmative. The author does not consider his experiments decisive.

A New Copper Nitrite.—B. van der Meulen.—The compound in question has the composition—

$$Cu(NO_2)_2 3CuO_2H_2.$$

Quantitative Determination of Cadmium.—F. Beilstein and L. Jawein.—The authors dissolve the precipitated cadmium sulphide (or oxide) in nitric acid, neutralise with potassa, and add potassium cyanide till the precipitate is just re-dissolved. The liquid is then if necessary diluted with water so that 75 c.c. may contain about 0·2 grm. cadmium. The beaker with the solution is then placed in a capsule with cold water, the platinum electrodes are introduced, and the glass is carefully covered to prevent loss by spirting. Three Bunsen elements are required for precipitation. Towards the end of the experiment the glass cover, the electrodes, and the sides of the beaker are rinsed down into the liquid, and the current is allowed to pass for some time longer. The completeness of the precipitation may be ascertained by testing the liquid with sulphuretted hydrogen. The precipitated cadmium is washed first with water, then with alcohol, and dried in a heated platinum capsule.

Action of Alcoholic Solutions of Potassa upon α-Dinitro-chlor-benzol Dissolved in the same kind of Alcohol. Preparation of α-Dinitro-phenylen-ethyl-ether, of α-Dinitro-phenyl-allyl-glycerin, and Phenyl-ether.—C. Willgerodt.—This paper does not admit of useful abstraction.

Action of Basic Bodies upon α-Dinitro-chlor-benzol in a Solution of Carbon Disulphide. Preparation of Dialpha-dinitro-phenyl-sulphide.—C. Willgerodt.—The author obtains yellow, sparingly soluble, pulverulent bodies, which do not melt at 280° to 300°, but generally explode at higher temperatures.

Action of Hydrocyanic and Hyrochloric Acids upon Methyl-acetic Ether.—H. König.—The author obtains oxyadipic acid by a reaction similar to that by which Demarçay prepares oxypyrotartaric acid.

Contribution to a Knowledge of the Substituted Nitrogen Chlorides.—H. Kœhler.—The author supports the view of Wurtz that ethyl-amin-bichloride is truly an ethylated nitrogen chloride.

Aromatic Sulpho-ureas.—B. Rathke.—Both mono- and diphenyl-sulpho-urea dissolve in aqueous potassa and soda (but not in liquid ammonia), and are re-precipitated unchanged by acids, even in carbonic. The same rule holds good with phenyl-xanthogenamid.

Action of Phenylated Oil of Mustard upon Diphenyl-guanidin.—B. Rathke.—By this reaction the author obtains a new base readily soluble in chloroform, but sparingly in benzol and alcohol. The author has been prevented by ill health from completing its examination.

On Biguanide.—B. Rathke.—A very complete description of this new base, $C_2N_5H_7$, which the author considers as formed by the union of equal molecules of guanidin and cyanimide.

Preparation and Analysis of Potassium Ultramarine.—Karl Heumann.—The author obtains this compound as a blue powder by the reaction of an excess of melting potassium chloride or iodide upon silver ultramarine.

The Thermo-mechanical Relation between the Boiling-point and the Melting-point of the Solid Elements.—H. F. Wiebe.—The author undertakes to show that for a series of bodies that quantity of heat which is requisite at the constant pressure of one atmosphere to raise equal volumes of the same from the melting-point to the boiling-point bears the same constant proportion to their inverse absolute coefficients of expansion.

Remarks on O. Dœbner's Paper on "Malachite Green."—E. and O. Fischer.—This paper relates, first, to the personal question of the priority of discovery, and, secondly, to the constitution of colouring-matter.

Colouring-Matters of the Rosanilin Group.—E. and O. Fischer.—An account of benzoyl-green, of its reduction, and of its para- and meta-nitro compounds.

On Para-cresol.—E. Baumann and L. Brieger.—Para-cresol is the chief constituent of the mixture of phenols obtained during the putrefaction of albumen, and regarded hitherto exclusively as phenol. It is also the chief constituent of the volatile phenols obtained on distilling the urine of horses with hydrochloric acid.

Brom-phenyl-mercapturic Acid.—E. Baumann and C. Preusse.—The authors describe the results of an experiment where a dog received daily doses of brom-benzol. The urine was found to contain sulpho-brom-phenolic acid in abundance. They then describe the decomposition of brom-phenyl-mercapturic acid by boiling with alkalies and by acids.

A Series of Homologous Tertiary Diamins observed in the Manufacture of Methyl-anilin.—O. Dœbner.—The author describes the first member of this series, $C_{17}H_{22}N_2$. A base, $C_{19}H_{26}N_2$, examined by A. W. Hofmann and Martius belongs to the same series.

Benzyl-methyl-glycolic Acid.—S. Gabriel and A. Michael.—The authors have been engaged with the attempt to prepare bezyl-methyl-glycolic acid by the action of hydrocyanic and hydrochloric acids upon phenyl-aceton, and then to reduce it to benzyl-methyl-acetic acid.

Oxytoluylic Acids obtained from the three Isomeric Cresols by means of Carbon Tetrachloride, and their Oxidation to Oxyphthalic Acids.—C. Schall.—This paper does not admit of useful abstraction.

Textile Colorist. Vol. i., No. 3.

This issue contains a variety of useful matter. The history of aniline by P. Prunier, described as being copyright, contains very little indeed that has not gone the round of chemical manuals. Articles borrowed from other journals are acknowledged in a somewhat unsatisfactory manner. Thus, certain instructions for testing the dyes of coloured fabrics are said to be from the *Gazette*, and a paper on aniline-black is ascribed to the *Bulletin*. Such references seem to us too vague. In the last-mentioned paper we read :—"A *queer* shade is thus obtained, which, after washing and scouring, becomes a pure black." We should suppose that a *green* shade is meant. Further on a patent process is described as involving the use of a solution of "ferrugineous chlorine." Attention to correctness in technical terms will greatly increase the value of the paper.

MISCELLANEOUS.

The British Association.—At the concluding meeting of the British Association at Sheffield, Captain Galton, having read the report of the General Committee, said that the numbers attending the meetings of the Association were, old life members 184, new life members 16, old annual members 239, new annual members 74, associates 529, ladies 349, foreign members 13, total 1404, and the amount in money was £1425. The grants, amounting to £960 were appropriated as follows:—

	£	s.	d.
A.—Mathematics and Physics.			
Dr. Lodge—New Form of High Insulation Key	10	0	0
Prof. Adams—Standard of White Light	20	0	0
Prof. Everett—Underground Temperature ..	10	0	0
Dr. Joule—Determination of the Mechanical Equivalent of Heat	50	0	0
Sir. W. Thomson—Elasticity of Wires	50	0	0
Mr. Glashier—Luminous Meteors	30	0	0
Mr. G. H. Darwin—Lunar Disturbance of Gravity	30	0	0
Prof. Sylvester—Fundamental Invariants ..	50	0	0
Mr. J. Perry—Laws of Water Friction	20	0	0
Prof. W. E. Ayrton—Specific Inductive Capacity of Sprengel Vaccum..	20	0	0
Rev. Prof. Haughton—Completion of Tables of Sun-heat Coefficients	50	0	0
Prof. G. Forbes—Instruments for Detection of Fire-damp in Mines	10	0	0
Mr. J. M. Thomson—Inductive Capacity of Crystals and Paraffins	25	0	0
B.—Chemistry.			
Prof. Dewar—Spectrum Analysis	10	0	0
Dr. Wallace— Development of Light from Coal-gas	10	0	0
C.—Geology.			
Prof. P. M. Duncan—Report on Carboniferous Polyzoa	10	0	0
Prof. A. L. Adam—Caves of South Ireland ..	10	0	0
Prof. Seeley—Viviparous Nature of Icthyosaurus	10	0	0
Mr. John Evans—Kent's Cavern Exploration..	50	0	0
Mr. John Evans—Geological Record	100	0	0
Prof. W. C. Williamson—Miocene Flora of the Basalt of North Ireland	15	0	0
Prof. Hull—Underground Waters of Permian Formations	5	0	0
D.—Biology.			
Dr. Pye-Smith—Elimination of Nitrogen by Bodily Exercise	50	0	0
General M. Lane-Fox—Anthropological Notes	20	0	0
Mr. Stainton—Record of Zoological Literature	100	0	0
Dr. M. Foster—Table at Zoological Station at Naples	75	0	0
Dr. A. Gamgee—Investigation of the Geology and Zoology of Mexico	50	0	0
Sir J. Lubbock—Excavations at Port Stewart	15	0	0
F.—Statistics and Economic Science.			
Dr. Farr—Anthropometry	50	0	0
G.—Mechanics.			
Mr. Bramwell—Patent Laws	5	0	0

The meeting in 1880, will be held at Swansea commencing on August 25, under Presidency of Prof. Ramsay, LL.D., F.R.I. In 1881 the Association will revisit York, where the first meeting, in 1831, was held.

University of London.—The following is a list of the candidates who have passed the recent Examinations for Honours, First B.Sc., and Preliminary Scientific (M.B.) Examinations:—

(First B.A. and First B.Sc. conjointly.)

Mathematics—First Class: S. Loney, First B.A., Sidney Sussex College, Cambridge. Second Class: Upendra Krishna Dutt, First B.Sc. and Prel. Sci., University College. Third Class: T. G. Creak, First B.A., Owens College.

(First B.Sc. and Preliminary M.B. conjointly.)

Chemistry—First Class: A. P. Luff, Prel. Sci., St. Mary's Hospital; J. S. W. Chitty, First B.Sc., Magdalen College, Oxford; W. A. Gostling, Prel. Sci., University College. Second Class: W. L. Goodwin, First B.Sc., University of Edinburgh; Frances H. Prideaux, Prel. Sci., London School of Medicine for Women; Emily Tomlinson, Prel. Sci., Girton College, Cambridge. Third Class: A. K. A. Spiegel, First B.Sc., Owens College; W. E. Wynter, Prel. Sci., St. Bartholomew's and Middlesex Hospitals; H. Duncan, Prel. Sci., University College; J. Stevenson, Prel. Sci., Owens College; P. F. Frankland, First B.Sc., Royal School of Mines and private study; A. J. Turner, Prel. Sci., University College.

Experimental Physics—First Class: J. Ryan, First B.Sc. (disqualified by age for the Arnott Medal), Cambridge (unattached). Second Class: H. Duncan, Prel. Sci., University College; W. A. Slater, Prel. Sci., Guy's Hospital; E. P. Cockey, Prel. Sci., Epsom College; S. Young, First B.Sc., Owens College; W. L. Goodwin, First B.Sc., University of Edinburgh; A. J. Turner, Prel. Sci., University College; F. Womack, Prel. Sci., St. Bartholomew's Hospital; R. B. Lee, First B.Sc., private study. Third Class: W. E. Wynter, Prel. Sci., St. Bartholomew's and Middlesex Hospitals; P. P. Whitcombe, Prel. Sci., Epsom College and St. Mary's Hospital; T. R. Dallmeyer, First B.Sc., University College and private study; S. F. Harmer, First B.Sc., University College; H. Settle, Prel. Sci., St. Bartholomew's Hospital; C. S. Spong, Prel. Sci., Epsom College and Guy's Hospital.

Botany—First Class: A. M. Vann, Prel. Sci., King's College; G. W. Hill, First B.Sc., King's College and St. George's Hospital. Second Class: R. F. Fox, Prel. Sci., private study and London Hospital; Catherine Alice Raison, First B.Sc., private study; T. S. Short, Prel. Sci., King's College.

Zoology—First Class: B. F. Halford, Prel. Sci. (Exhibition), University College; A. J. Turner, Prel. Sci., University College. Second Class: T. W. Shore, Prel. Sci., Hartley Institute and Royal School of Mines. Third Class: S. S. Merrifield, Prel. Sci., King's College; A. E. Taylor, Prel. Sci., University College.

(First M.B. Examination.)

Organic Chemistry—First Class: E. L. Adeney (Exhibition and Gold Medal), Guy's Hospital; *W. Lane, Guy's Hospital; C. P. Lukis, St. Bartholomew's Hospital. Second Class: J. J. Udale, Guy's Hospital. Third Class: R. Prothero, Liverpool School of Medicine and Guy's Hospital; R. Sisley, St. George's Hospital.

Materia Medica and Pharmaceutical Chemistry—First Class: A. Barron (Exhibition and Gold Medal), Owens College and Liverpool Royal Infirmary; †A. Daniell, Universities of Edinburgh and Paris; W. T. Maddison, King's College. Second Class: A. G. Dawson, Owens College; J. M. Rogers, Middlesex Hospital; T. G. Stonham, London Hospital; G. C. R. Bull, St. Mary's Hospital; W. E. Fielden, Guy's Hospital.

* Obtained the number of marks qualifying for a Medal.
† Obtained the number of marks qualifying for the Exhibition.

NOTICE.

The STUDENTS' NUMBER of the Chemical News will be published on Friday, September 12th. Gentlemen holding official positions in the Universities, Colleges, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the education, who have not yet forwarded the necessary information to our Office for publication in that Number, will confer a favour by sending it with the least possible delay.

THE CHEMICAL NEWS.

Vol. XL. No. 1033.

ADDRESS TO STUDENTS.

During the last twenty years so many "Addresses to Students" have appeared in the Chemical News as prefaces to the annual "Students' Number" that it has become difficult—nay, almost impossible—to say anything new. We have done our best—but, alas! unsuccessfully—to exorcise that evil spirit "Cram;" we have steadily advocated the necessity of wedding practice to theory by indissoluble bonds; we have warned the warm-blooded young student against theoretical Will-o'-the-wisps and formulistic Jack-o'-Lanthorns; and we have tried to prove to him the fallacy of trying to follow too many paths at once, by showing that all truly great philosophers, whether chemists or physicists, were men of a single and steadily followed aim, until we have worn every subject to shreds. We have, therefore, resolved to be personally silent on the present occasion, and intend to confine ourselves to picking out a few passages from a speech made by that Ithuriel of the "Cram Demon," Prof. Huxley, to the London University College schoolboys at the annual distribution of prizes on July 31st. Although delivered to boys still at school, it contains a notable amount of good advice that may be taken to heart by students of all ages.

The beginning of the Professor's address was a telling sketch of the kind of boys who win prizes, a sketch which will equally apply to men who are successful in carrying off the more or less solid honours of the University. Quickness in learning, readiness and accuracy in reproducing, industry, and, above all, endurance, are the essential characteristics of the prize winner *par excellence*. We may, however, venture to suggest that Prof. Huxley describes the typical prize winner as he would like to see him rather than as he is. As an instance of this it may be stated that not so very long ago a certain student, who had never handled a dissecting knife, carried off the B.A. prize, as well as honours in Animal Physiology, by dint of an excellent memory. Prof. Huxley justly places the power of bearing both mental and physical fatigue in the very front of the qualifications of a successful student, and reminded his hearers that this power is not necessarily the concomitant of either great mental or physical strength. To a lawyer, physician, or merchant, the power of being able to work for fifteen or sixteen hours at a stretch without being knocked up may make all the difference between success and failure.

College life once past, Prof. Huxley asks from the would-be successful competitor as much industry as he can bring to bear on his particular subject, a broad deep chest, and a stomach of whose existence he knows nothing. Competitive examination is only a partial test of what the prize winners will be in after life. The student just referred to is now a Government clerk; and a contemporary of his who in the same year carried off prizes and honours in chemistry without ever having cleaned a test-tube in his life, is now one of our leading musical composers and critics. A more practical and instructive commentary on the evils of "cram" could hardly be found than is afforded us by these two cases. The real gist of the matter is that those who fail at college are more than frequently successful competitors in the great struggle for a place in the world's lists. "Those," said Prof. Huxley, "who have won prizes have made a good beginning; those who have not, may yet make that good ending which is better than a good beginning. Professor Circumstance is the severe pedagogue who conducts the long competitive examination of practical life."

Let those, therefore, who not only win no prizes, but who fail even to pass, take heart of grace. The winners of rewards and places unquestionably give promise of doing great things in the future. But how many of them have become distinguished members of society? Whilst among the undistinguished crowd there may be some simple student with whose name the world may one day ring. The unsuccessful ones, then, who go down before their more brilliant compeers should remember that in the battle of life the steady-burning farthing rushlight is of more real value than the dazzling meteor which flashes across half the firmament. Win prizes and honours if you can. If you have the other qualities necessary for success in this world, such distinctions will only act on you as a mental tonic, a sharp but necessary spur to goad you on to reach the goal; but if, in spite of all your industry and perseverance, you find yourself at the bottom of the list, comfort yourself with the feeling that as long as you possess industry, honesty, and courage, the greater and more enduring prizes of the world are still open to you.

Twenty years ago the late J. G. Edgar wrote a charming boy's book, entitled the "Boyhood of Great Men." For the encouragement of those who have been unsuccessful in carrying off prizes at school or college, will no one write a companion to this, to be called the "Manhood of Great Boys?"

In a leader on the subject of competitive examinations and the cramming system generally, the *Times* makes the following apposite and incisive remarks:—

> "Several circumstances have combined of late to direct public attention to the subject of examinations. Cambridge, as we saw a short time ago, is forced seriously to consider the system of entrance scholarships; and a correspondent has recently invited attention to the mischievous system of entrance scholarships established in public schools. Even if examinations were a good in themselves, it would still be possible to have too much of a good thing, and very many competent judges are already beginning to dread an educational surfeit in this respect. But, to our thinking, examinations, so far from being a good in themselves, can hardly be placed higher than the category of necessary evils. They are a burden to the examiner and to the teacher, exactly in proportion as each is efficient and conscientious, and they are very far from being an unalloyed benefit even to the examinee. But they are not the less in many cases necessary; they are at least a rough test of merit, capacity, and attainment, and therefore, where these have to be tested for any specific purpose, it is hardly possible to dispense with examination altogether. But to admit this much is very far from saying that examinations should be made, what they are fast becoming, the be-all and end-all of educational processes. From the tender age of ten or eleven to that of manhood and upwards nearly every boy of promising parts in this country lives with the constant fear of examinations before his eyes. If he is more than usually suc-

cessful, at the end of the process he is likely to enjoy for the next few years, or, indeed, as long as he chooses, the distinguished privilege of examining his juniors in their turn. Thus the examination fever spreads far and wide. It spares neither age nor sex; for women, with singular perversity, have claimed as a privilege what boys and men alike regard with aversion. It has long ago pervaded education, and its contagion is now beginning to infect the whole range of modern letters. Literature, ancient and modern, is regarded as so much material for examination to be reproduced in the form best calculated to win marks in a competition. History is cut up into "periods" and "epochs," and then reduced into summaries, so that whoso runs may read or teach, examine or be examined. The old Universities, which once could boast of a learned press and still occasionally publish works not unworthy of English scholarship, devote their chief literary energies to the publication of manuals required in the various examinations they have undertaken to conduct. The work is excellently done, no doubt, though it is hardly of a kind which befits the dignity of an Academical press. But the examination spirit is rampant, and the Universities are forced to yield to it. The pity of it is that they take to the task so kindly and seem so entirely contented with it.

"The evil of all this is unquestionably great and growing. We need not dwell on the diastrous effects, well known to schoolmasters and college tutors, of the premature forcing for the purpose of competitive examination to which so many boys of tender years are now submitted in public schools. It is rather to the general effects of the modern tendency to make examination the sole test and crown of all processes of education that we wish to draw attention. This tendency entirely distorts every rational view of what education is and should be. It makes of the pupil a mere racer, and one who contends for heavy pecuniary stakes. It makes of the teacher a trainer whose whole prosperity depends, not on his power of imparting sound knowledge and drawing out the natural capacities of the mind, but on his skill in preparing his pupils for a particular competition. It makes of the examiner a judge, not of mental capacity and sound information generally, but of those qualities alone which are readily estimated in marks. In addition to all this the system tends inevitably to force teaching and examining alike into a narrow and mechanical groove. Even if a particular teacher has a special taste and regard for some subject out of the ordinary range of the examination for which he is preparing his pupils, he dare not lead them in the direction in which he would probably do them most good, for fear they should fail to get credit for their work in the coming ordeal, on which their whole success in life may depend. He is forced to scan with anxious scrutiny the line that the examination has previously taken, in the confidence, very rarely misplaced, that it will take the same line again. For the examiner knows that he, too, must not go beyond certain well-understood limits. If he does, he will be regarded as crotchety, unfair, and pedantic. Every experienced teacher knows to his cost how the attempt to lead his pupils towards some collateral line of study not directly recognised in an examination is frustrated at once by their refusal to take any interest in subjects that will not "pay." Every examiner knows that the insertion in his papers of a question lying somewhat out of the recognised range and groove is simply so much waste of time and labour. Hence, under the influence of examinations, the treatment of every subject, great and small, is divided, by an impassable barrier, into the dark and boundless range of the neglected and the unknown, which the teacher must leave unnoticed and the examiner dares not explore, and the narrow field, brilliantly illuminated and minutely surveyed, which the pupil is taught to regard as alone worthy of notice. Even thus we have not exhausted the evil effects of thus substituting examination for education. The whole system gives the successful competitors an exaggerated sense of the importance of the victories they have won. It unduly stimulates their earlier efforts, while it paralyses their later and more mature energies. A high wrangler or a first-class man thinks that the battle of life is won. He has learnt all that he can learn, has done all that he needs to do. He despises knowledge which lies outside the examination range as musty, pedantic, and unprofitable. He thinks meanly of men who have not been examined so often or so successfully as himself. He owes all that he is, and has, and knows to having been examined: he believes in the process, and he aims at nothing higher than being in his turn an examiner himself. Then, indeed, his fate is sealed: he might have been a student, a scholar, or a philosopher if he had not been taught to look at all knowledge through the distorting medium of examinations; he might even have succeeded in life, in spite of early obstacles and mischievous training, if he had not been led to believe that that success was already won at its outset. But he becomes a mere subordinate wheel in a vast and exacting machine; his existence is passed in a weary and monotonous round of setting papers and looking them over, of assigning marks and adding up their total, of comparing results with his colleagues and striving to gauge human nature by impossible measurements and fallacious standards, until at last he comes to believe that there is no better fate in store for human beings than to become just what he is himself.

"The picture we have drawn is highly coloured, perhaps, but it will the better serve to illustrate the inevitable consequences of making examination supreme, instead of keeping it in proper subordination to the higher purposes of education. It used to be said that in some districts of England a man could be supported by charity from his cradle to his grave. We have changed all that, and in the place of indiscriminate charity we have established the supremacy of examinations at every turn in life. Is the result so entirely satisfactory that we can regard it as final and irrevocable? Is it not possible that, as so often happens, we have confounded ends with means and made a successful examination the paramount purpose, instead of merely the indispensable test, of educational training? What, in fact, is the actual result? Education is doubtless improved in its lower ranges, and the public service of the country has been purged of mere favour and nepotism. These are valuable and indisputable gains; but they would be purchased dearly by the sacrifice of high aims in academical culture and the absorption of some of the best capacity of the country in a kind of work which extinguishes original study and paralyses all intellectual independence. If we persist in absorbing some of the best capacity of Oxford and Cambridge in the perpetual conduct of trivial and elementary examinations, can there be any reasonable chance of those Universities producing results proportionate to their fame and endowments in the real work of learning?"

Such sentiments coming from the leading journal will be read with gratification by all true friends of education, who will rejoice to see the *Times* joining in the battle against the cram system, a battle which the Chemical News has fought unflinchingly from its first number.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

Candidates for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

The Examination will be held on Monday, January 12th, 1880. It is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. Arithmetic and Algebra. Geometry. The English Language and English History. Natural Philosophy. Chemistry.

The Papers in Latin and Greek will contain passages to be translated into English, with questions in Grammar and History and Geography arising out of the subjects of the books selected. Short and easy passages will also be set for translation from other books not so selected. A separate paper will be set containing questions in Latin Grammar, with simple and easy sentences of English to be translated into Latin.

Candidates may substitute German for Greek.

The papers in French and German will contain passages for translation into English, and questions in Grammar, limited to the Accidence. The paper in Sanskrit or Arabic will contain passages for translation into English, and questions in Grammar.

The examination in the English Language and English History includes Orthography; Writing from Dictation; the Grammatical Structure of the Language.

History of England to the end of the Seventeenth Century.

That in Mathematics includes the ordinary Rules of Arithmetic; Vulgar and Decimal Fractions; Extraction of the Square Root.

Addition, Subtraction, Multiplication, and Division of Algebraical Quantities; Proportion; Arithmetical and Geometrical Progression; Simple Equations.

The First Four Books of Euclid, or the subjects thereof.

The Questions in Natural Philosophy are of a strictly elementary character; they include Mechanics, Hydrostatics, Hydraulics, Pneumatics, Optics, and Heat.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the First LL.B. Examination, or at the Preliminary Scientific and First M.B. Examinations, within three academical years* from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the First B.A. or to the First B.Sc. Examination in the following July. But such Candidate will not be admissible to the Second B.A. or to the Second B.Sc. Examination in the ensuing year, unless he has attained the age of eighteen years.

First B.Sc. Examination.

The First B.Sc. Examination will be held in July, 1880.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

The Examination embraces the following subjects:—Pure and Mixed Mathematics, Inorganic Chemistry, Experimental Physics, and General Biology.

Examination for Honours.

Any Candidate who has passed the First B.Sc. Examination in all its subjects may be examined at the Honours Examination next following the First B.Sc. Examination at which he has passed for Honours in (1) Mathematics, (2) Experimental Physics, (3) Chemistry, (4) Botany, and (5) Zoology; unless he has previously obtained the Exhibition in Pure and Mixed Mathematics at the First B.A. Examination, in which case he will not be admissible to the Examination for Honours in that subject; or unless he has previously obtained the Exhibition at the Preliminary Scientific (M.B.) Examination in either of the subjects which are common to it with the first B.Sc. Examination, in which case he will not be admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative and Quantitative Analysis. This Examination, which will consist of six hours' examination by printed papers and of six hours' practical work, will take place on Thursday and Friday in the same week with the Examination for Honours in Mathematics, commencing on each day at 10 a.m.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself in Chemistry or Experimental Physics, will receive an Exhibition of £40 per annum for the next two years.

Second B.Sc. Examination.

The Second B.Sc. Examination will be held in October, 1880.

Candidates for this Examination are required to have passed the First B.Sc. Examination at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to bring up *any three* of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Logic and Psychology.

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* By the term "Academical Year" is ordinarily meant the period intervening between any Examination and an Examination of a higher grade in the following year; which period may be either more or less than a Calendar year. Thus the interval between the *First* Examinations in Arts, Science, and Medicine, and the *Second* Examinations of the next year in those Faculties respectively, is about sixteen months, whilst the interval between the Second B.A. Examination and the M.A. Examination of the next year, or between the Second B.Sc. Examination and the D.Sc. Examination of the next year, is less than eight months. Nevertheless, each of these intervals is counted as an "Academical Year."

It is understood the amount of proficiency expected in each of the three subjects chosen will be that which the candidate might attain by the steady devotion to it of about one-third of the sessional work of a diligent student.

Examination for Honours.

Any Candidate who has passed the Second B.Sc. Examination, and has not previously passed the Second B.A. Examination, may be examined at the Honours Examination next following the Second B.Sc. Examination at which he has passed, for Honours in (1) Mathematics, (2) Logic and Psychology, (3) Experimental Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) Physiology, (8) Physical Geography and Geology; provided that he shall have gone through the Pass Examination in the corresponding subject or subjects immediately before. And any Bachelor of Arts who has passed the Second B.Sc. Examination may under the same conditions be examined for Honours in one or more of the above mentioned subjects, unless he have previously obtained a Scholarship at the Second B.A. Examination in either of the first two of those subjects, in which case he shall not be admissible to the Examination for Honours in that subject.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the second week after the conclusion of the Pass Examination; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

DOCTOR OF SCIENCE.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June, and the examination in each branch occupies four days.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University, unless he shall have passed the Second B.Sc. Examination in the First Division at least two Academical years subsequently to having passed the first B.Sc. Examination, in which case he shall be admitted to the examination for the Degree of Doctor in Science at the expiration of *one* Academical Year from the time of obtaining his B.Sc. Degree.

The Fee for this Examination is £10.

Every candidate for the degree of D.Sc is examined in some one or more of the various branches of Physical, Biological, or Mental Science, to be selected by himself; and no candidate is approved by the examiners unless he has shown a thorough practical knowledge of the principal subject and a general acquaintance with the subsidiary subject or subjects, specified as belonging to the branch so selected. He is expected to be so fully conversant with the principal subject he may select as to be able to go through any examinational test (whether theoretical or practical) of his acquirements in it that can be fairly applied. Candidates, when giving notice, must specify the branch or branches in which they desire to be examined.

BRANCH IV. OF PHYSICAL SCIENCE.
INORGANIC CHEMISTRY.

Principal Subject—Inorganic Chemistry.

Subsidiary Subject—Either Organic Chemistry; or Mineralogy, Crystallography, and Chemical Technology in its relations to Inorganic Chemistry.

BRANCH V., ORGANIC CHEMISTRY.

Principal Subject—Organic Chemistry.

Subsidiary Subjects—Either Inorganic Chemistry; or Chemical Technology in its relations to Organic Chemistry, and the Chemistry of Animal and Vegetable Life.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.

This examination will be held in July, 1880.

No Candidate is admitted to this examination until he has completed his seventeenth year, and has either passed the Matriculation Examination* or taken a Degree in Arts in one of the Universities of Sydney, Melbourne, Calcutta, or Madras (provided that Latin was one of the subjects in which he passed). The fee for this examination is five pounds.

Candidates for the degree of M.B. are strongly recommended by the Senate to pass the Preliminary Scientific Examination before commencing their regular medical studies; and to devote a preliminary year to preparation for it according to the following programme:—Winter Session: Experimental Physics; Chemistry (especially Inorganic); Zoology. Summer Session: Practical Chemistry (Inorganic); Botany.

Any candidate who has passed the Preliminary Scientific (M.B.) Examination, may be examined at the Honours Examination next following the Preliminary Scientific Examination at which he has passed, unless he has previously obtained an Exhibition in any one of the subjects at the First B.Sc. Examination, in which case he is not admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry are examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition they are examined practically in Simple Qualitative and Quantitative Analysis.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in ths University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

Candidates are examined in the following subjects:—

Chemistry and Microscopy, in relation to the examination of Air, Water, and Food.

Meteorology and Geology, as far as they bear on the duties of Health Officers, viz.:—General knowledge of Meteorological Conditions; Reading and Correction of Instruments. General knowledge of Soils; their Conformation and Chemical Composition.

Vital Statistics, in reference to the methods employed for determining the Health of a Community; Birth-rate; Death-rate; Disease-rate; Duration and of Expectancy of Life. Present amount of Mortality, and its causes, in different Communities.

Hygiene.—General principles of Hygiene. Special topics:—Soil. Construction of Dwellings. Conservancy of Cities. Unhealthy Trades. Supply of Food to Cities, and Examination of Food. Disposal of Sewage. Water-supply.

Medicine, in reference to the origin, spread, and method of prevention of Diseases generally, but especially those of the Epidemic class.

Sanitary Engineering, as far as regards the arrangements connected with Water-supply, Sewerage, and Ventilation. A knowledge of the reading of Plans, Sections, Scales, &c.

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* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure Mathematics of the First B.Sc. Examination, or who have previously passed the First B.A. Examination, are considered as having passed the First B.Sc. Examination. The attention of such candidate directed to the fact that, under the new regulations for the B.Sc. Degree, this degree may be obtained by passing at the Second B.Sc. Examination in the three Biological subjects only.

Sanitary Law, as far as it relates to the duties of Officer of Health. A knowledge of the powers given under the various Sanitary Acts, as defined in the Instructions issued by the Local Government Board, and of the methods of procedure in special cases.

The Examination, which is both written and practical, extends over four days.

Gilchrist Scholarships.

1. A Scholarship of the value of Fifty Pounds per annum, and tenable for three years, is annually awarded to the highest among those candidates at the June Matriculation Examination who have been approved by the Principal of University Hall as fit to be received into that Institution with a view to the prosecution of their studies in University College for Graduation in one of the four Faculties of the University of London; provided that such Candidate pass either in the Honours List or in the First Division.—Particulars may be obtained on application to the Principal of University Hall, Gordon Square, W.C.

2. A similar Scholarship is annually awarded to the Candidate from the Royal Medical College, Epsom, who at the June Matriculation Examination stands highest among the Candidates approved by the Head Master of that Institution, and who passes either in the Honours List or in the First Division; on condition of his prosecuting his studies during the tenure of his Scholarship with a view to Graduation in one of the four Faculties of the University of London.—Particulars may be obtained on application to the Secretary of the Royal Medical College, 37, Soho Square, W.

3. A similar amount is annually offered to Candidates intending to pursue, at Owens College, Manchester, their studies for Graduation in one of the four Faculties of the University of London; a single Scholarship of Fifty Pounds per annum for three years being awarded to the highest of those Candidates at the June Matriculation Examination who shall have been previously approved by the Principal of Owens College, provided that he pass in the Honours Division; or, in case no Candidate should so pass, two Scholarships, each of Twenty-five Pounds per annum, being awarded to the two Candidates as aforesaid who shall stand highest in the First Division.—Particulars may be obtained on application to the Principal of Owens College, Manchester.

Particulars of the Colonial and Indian Scholarships may be obtained on application to the Secretary of the Gilchrist Educational Trust, University of London, W.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom. The object of the grant is to promote instruction in Science, especially among the industrial classes, by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.

In order to place a science school or class in connection with the Science and Art Department, an approved committee, consisting of at least five well known and responsible persons, must be formed.

The following are the sciences towards instruction in which aid is given by the Science and Art Department:—Practical, Plane, and Solid Geometry; Machine Construction and Drawing; Building Construction; Naval Architecture and Drawing; Pure Mathematics; Theoretical Mechanics; Applied Mechanics; Acoustics, Light, and Heat; Magnetism and Electricity; Inorganic Chemistry; Organic Chemistry; Geology; Mineralogy; Animal Physiology; Elementary Botany; Biology, including Animal and Vegetable Morphology and Physiology; Principles of Mining; Metallurgy; Navigation; Nautical Astronomy; Steam; Physiography; Principles of Agriculture.

The aid is given in the form of—1. Public examinations, in which Queen's Prizes are awarded, held at all places complying with certain conditions; 2. Payments on results as tested by these examinations; 3. Scholarships and Exhibitions; 4. Building grants; 5. Grants towards the purchase of fittings, apparatus, &c.; 6. Supplementary grants in certain subjects, and special aid to teachers and students.

The examinations are held about the month of May under the superintendence of the local committees and local officers. The examination papers are prepared by the professional examiners in London. An evening is set apart for one or more subjects, so that the examination in each subject is simultaneous over the whole kingdom.

A packet of examination papers is sent to each local examination secretary, who opens it in the presence of the committee and candidates. The committee is held responsible that no unfair means of any description are used in working the papers, and that the rules of the Department are strictly complied with.

The examinations are of two kinds, but held together, viz.—

a. The Class examinations, of which there are two grades or stages; the first stage or elementary examination, and the second stage or advanced examination. The successful candidates in both stages are divided into 1st and 2nd class.

b. The Honours examination of a highly advanced character. In this there are also two classes.

Any person however taught may sit at any one of these examinations.

The Queen's prizes, consisting of books or instruments, are also given to all candidates who are successful in obtaining a first class in either stage of the class examinations.

The payments on results are made only on account of the instruction of students of the industrial classes, or on account of the instruction of their children. They are—£2 for a first class, and £1 for a second class, in each stage of the class examinations, and £2 and £4 for a second or first class respectively in honours. Special extra payments are made in attendance in organised Science Schools. Special payments are also made for Chemistry.

There are also two forms of scholarship in connection with elementary schools.

a. In the Elementary School Scholarship £5 are granted to the managers of any elementary school for the support of a deserving pupil selected by competition, if they undertake to support him for a year and subscribe £5 for that purpose. The payment of £5 by the Science and Art Department is conditional on the scholar passing in some branch of science at the next May examination.

b. In the Science and Art Scholarship, which is of a more advanced character, a similar contribution of £5 is required on the part of the locality, and a grant of £10 is made by the Department towards the maintenance, for one year, of the most deserving pupil or pupils in elementary schools who have passed certain examinations in science and in drawing.

In both these cases the scholar must be from twelve to sixteen years of age, and one scholarship is allowed per 100 pupils in the school.

There are also two forms of Exhibitions. These are:—

a. Local Exhibitions to enable students to complete their education at some college or school where scientific instruction of an advanced character may be obtained. Grants of £25 per annum, for one, two, or three years are made for this purpose when the locality raises a like sum by voluntary subscriptions. And if the student attend a State School, such as the Royal School of Mines in London, the Royal College of Chemistry in London, or Royal College of Science in Ireland, the fees are remitted.

b. Royal Exhibitions of the value of £50 per annum tenable for three years, to the Royal School of Mines, London, and the Royal College of Science, Dublin, are given in competition at the May examinations. Six are awarded each year—three to each institution. The exhibitions entitle the holder to free admissions to all the Lectures, and to the Chemical and Metallurgical Laboratories at those two institutions.

The competition for the Whitworth Scholarships, tenable for three years, is also in part determined by the results of the May examinations.

A grant in aid of a new building, or for the adaptation of an existing building, for a School of Science may be made at a rate not exceeding 2s. 6d. per square foot of internal area, up to a maximum of £500 for any one school, provided that certain conditions are complied with and that the school be built under the Public Libraries and Museums Act, or be built in connection with a School of Art, aided by a Department building grant.

A grant towards the purchase of fittings, apparatus, diagrams, &c., of 50 per cent of the cost of them is made to Science Schools. And where a school is furnished with a laboratory, properly fitted up, payments are made on account of students who during the year receive 25 lessons in laboratory practice.

Special extra grants in the form of capitation payments are made in fully organised Science Schools.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus.*

Lectures by the Waynflete Professor on Mondays, and Thursdays at the Museum.

Lectures on Elementary Organic Chemistry will be given by the Aldrichian Demonstrator of Chemistry, Mr. W. W. Fisher, M.A., of Corpus Christi College, on Wednesdays and Saturdays, at 11 a.m.; and Lectures on Elementary Inorganic Chemistry by Mr. W. F. Donkin, M.A., of Magdalen College, on Tuesdays and Fridays, at 11 a.m.

The Laboratory of the University will be open from 10 a.m. to 4 p.m. daily, and instruction in Practical Chemistry will be given by the Aldrichian Demonstrator, and by Mr. John Watts, B.A., of Balliol College.

A Course of Practical Instruction in Organic Chemistry will be conducted by Mr. W. H. Pike, Ph.D.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

Demonstrators.—J. W. Hicks, M.A., W. J. Sell, B.A., and H. J. H. Fenton, B.A.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. They are under the superintendence of the Rev. R. B. Somerset, Orford House, Cambridge, from whom further information may be obtained.

The following are the Lectures on Chemistry for the ensuing Academical Year:—

MICHAELMAS TERM, 1879.

General Course, by the Professor of Chemistry, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 13.

Spectroscopic Analysis, by the Professor of Chemistry, on Mondays, Wednesdays, and Fridays, at 1.30 p.m. Begin Oct. 17.

Analysis, by the Professor and the Demonstrators of Chemistry. Daily. Begin Oct. 13. Also at St. John's College, by Mr. Main. Begin Oct. 15. Also at Caius College, by Mr. Pattison Muir; begin Oct. 15. Also at Sidney College. Begin Oct. 14.

Metals, by Mr. Pattison Muir. Monday, Wednesday, and Friday, at 10. Begin Oct. 15.

Physical Chemistry, by the Jacksonian Professor, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 14.

Elementary Organic Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Oct. 14.

Volumetric Analysis, by a Demonstrator, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 14.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Oct. 13.

Elementary Lectures on the more important Minerals, by the Deputy Professor of Mineralogy.

LENT TERM, 1880.

General Course continued, by the Professor of Chemistry, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Jan. 28.

Analysis, by the Professor or Demonstrators of Chemistry. Daily. Begin Jan. 19. Also at St. John's College. Begin Jan. 30. Also at Caius College Laboratory. Begin Jan. 31. Also at Sidney College Laboratory. Begin Jan. 30.

Organic Chemistry, by the Jacksonian Professor, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Jan. 29.

General Course, begun by Mr. Main, at St. John's Laboratory, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Jan. 28.

Non-metallic Elements, by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Feb. 4.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Jan. 30.

Easter Term, 1880.

Some Special Department, by the Professor of Chemistry, on Mondays and Fridays, at 12 noon. Begin April 14.

Analysis, by the Professor or Demonstrators of Chemistry. Daily. Begin April 26. Also at St. John's College. Begin April 24. Also at Caius College. Begin April 25. Also at Sidney College Laboratory. Begin April 22.

Elementary Chemistry, by the Demonstrator of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin April 13.

General Course concluded, by Mr. Main, at St. John's Laboratory, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin April 24.

Elementary Organic Chemistry and Analysis, by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 26.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin April 30.

Crystallography, by the Deputy Professor of Mineralogy.

UNIVERSITY OF DUBLIN.—TRINITY COLLEGE.

The Chemical Laboratory will re-open on October 1st, 1879.

The University Professor of Chemistry, Dr. Emerson Reynolds, F.R.S., assisted by the Demonstrator of Chemistry, Mr. Early, conducts the undermentioned Courses of Laboratory instruction:—

The First Course of Practical Chemistry.—Michaelmas Term:—Qualitative Analysis and the Use of the Spectroscope. Hilary Term: Volumetric and Simple Gravimetric Analysis. Trinity Term: Organic Preparations and Analysis.

Students can also attend the Professor's Lectures on General Chemistry, and repeat most of the experiments performed in the Theatre.

This Course terminates on the last day of June.

The Second or Advanced Course includes instruction in the higher branches of Experimental and Analytical Chemistry, and in Methods of Research. Students who take out this Course are free to devote their chief attention to the study of special departments of Chemistry as applied to Arts and Industries.

Summer Course of Practical Chemistry for Medical Students.—This Course commences on the first Monday in April and terminates on the 30th of June following. Students experiment in the Laboratory from 2 to 4 o'clock on Tuesdays, Thursdays, and Saturdays.

Special Courses.—Students can enter at any time throughout the academic year for short terms of Laboratory instruction in Medical or Pharmaceutical Chemistry, or in the Methods of Analyses of Water, Air, &c., for Sanitary Purposes.

Lectures in Medical and Pharmaceutical Chemistry.—Dr. Reynolds lectures at 2 o'clock on Tuesdays, Thursdays, and Saturdays, from the 1st of November to the 31st of March following.

All the classes are open to extra-Academic Students.

KING'S COLLEGE.

(Department of Engineering and Applied Science.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at interval during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £8 8s. od.; Experimental and Analytical Chemistry —One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1879-80, are Tuesday, September 30, Tuesday, January 13, and Wednesday, April 14.

UNIVERSITY COLLEGE.

Faculty of Science.

Chemistry.—Professor Williamson, Ph.D., F.R.S.

I. General Course.

Lectures daily (except Saturday) from 11 to 12 a.m., up to the last week in March.

Exercises on Tuesdays, Wednesdays, Thursdays, and Fridays, from 9 to 10 a.m.

Fees for the Course, £7 7s.; Perpetual, £9 9s.; for the Half Course, £4 4s.; for the Organic Course alone, £2 2s.

Fee for the Exercise Class, £2 2s.

The instruction in this Class is of two kinds, consisting partly of Experimental Lectures by the Professor, partly of Exercises and personal instruction on the subject of the Lectures by an Assistant.

Attendance on the Exercise Class (conducted by Mr. Temple A. Orme, F.C.S.) enables Students to do their work more effectually and rapidly than they can do it by themselves.

A. *The first half* of the course, to Christmas, includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

B. *The second half* of the Course, from January to March, includes the following subjects:—

1. Preparation and properties of the chief *Metals*, including their characteristic reactions and most important salts. Detection of metallic poisons. Quantitative estimation of metals. Principles of classification. Monatomic, diatomic metals, &c.

Organic Chemistry commences in the second week in February, and occupies five Lectures weekly till about the end of March. It includes a study of the characteristics and metamorphoses of the chief organic acids, bases, alcohols, ethers, colouring-matters, &c. Methods of ultimate and proximate analysis. Determination of molecular weights. Theory of types; of compound radicals. Phenomena of fermentation, &c.

Training of Teachers.

Teachers of Chemistry are trained in the theory and practice of their profession. A two years' Course is absolutely requisite for this purpose; but Students will with advantage devote a longer period to it.

The first year is occupied with attendance on the Courses of Chemistry and of Analytical Chemistry. In the second year the Student again attends the Course of Chemistry, and is intrusted with teaching-work in conjunction with the Tutors of the class. At the same time he continues to work in the Laboratory at analysis and original research.

In order to qualify themselves for rising to the higher ranks of the Profession, gentlemen remain for a further period, in which case they may obtain remunerative work in teaching through the recommendation of the Professor.

It must not, however, be supposed that a study of Chemistry alone, however complete, is sufficient to qualify a man to teach the Science effectively. A competent knowledge of Physics, Mathematics, and either French or German must necessarily be acquired at some period of the Student's Course.

II.—ANALYTICAL AND PRACTICAL CHEMISTRY.

A. *Birkbeck Laboratory.*

Assistants.—C. A. Bell, B.A., M.B., and Frank L. Teed.

When accompanied or preceded by attendance on the lectures on Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to the Manufacturing Arts, Metallurgy, Medicine, or Agriculture, &c. Instruction is given in the principles and processes of gas-analysis.

The Laboratory and offices are open daily from 9 a.m. to 4 p.m., from the 3rd of October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees, for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

B.—SUMMER PRACTICAL COURSES.

Chemical Theatre.

1. *Elementary Course.* (*Men.*)—About Forty Lessons, of one hour each, commencing in the first week of May.

The first six weeks of the Course are occupied by the study of the chief non-metallic elements and their simple compounds. Metallic salts, &c., are subsequently studied.

Fees—including the cost of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

2. *Senior Course.* (*Men.*)—This Course consists of Twenty Lessons of two hours each, commencing in the first week in May.

The first half of the Course includes tests for fixed and volatile organic acids, nitrogenised acids, sugars, glycerin, alkaloids, &c.

The second half of the Course includes tests for mineral poisons in organic mixtures; also tests for organic bodies, such as alkaloids, when mixed with other organic substances.

Volumetric methods of the quantitative analysis of sugar and urea, chlorides, phosphates, hardness of water, alkalimetry, are practised.

Analysis of milk and ashes of blood.

Fees—including the costs of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

III.—SUMMER MATRICULATION COURSE. (*Men.*)

TEMPLE A. ORME, F.C.S.

This Course includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

The Course consists of about Twenty Lessons in Practical Chemistry, and of an equal number of oral lessons. These lessons will begin on April 13th, 1880, at 11.

Fee, including cost of materials and apparatus, £4 4s.

ELEMENTARY CHEMISTRY.

Chemical Theatre. (*Women*).

Lectures—Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Winter Session by C. A. Bell, B.A., M.B., Chief Assistant in the Chemical Laboratory, commencing Wednesday, October 8.

The instruction will consist partly of Lectures, partly of Laboratory Experiments performed by the Students.

Fees for the Course, including use of apparatus and materials, £4 4s.

Chemical Technology.

Professor CHARLES GRAHAM, D.Sc.

Assistant.—Mr. Henry Brown.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

Assuming that the Student enters for a three years' study, the following will give an idea of the nature of the work during the period:—

In the first year the Student will attend Lectures on Theoretical Chemistry, and work at Analytical Chemistry in the Chemical Laboratory, and will also attend Lectures on Mathematics, Mechanics, and Physics. The Mechanical Drawing Class should also be attended during the first year by all Students.

In the second year, the Student will again attend the Lectures on Theoretical Chemistry, and will begin his study of Applied Chemistry by attendance on the Lectures in this subject, and by practical work in the Laboratory on the applications of Chemistry.

The third year will also be chiefly occupied with attendance on the Lectures on Chemical Technology, and in practical work connected therewith in the Laboratory.

In the second and third years the Student will, in addition to the foregoing subjects, which are common to all, attend Lectures and work at such other branches of Pure and Applied Science as may be deemed advisable after consultation with the Professor.

Students entering the College with more advanced scientific knowledge will be able to shorten the Course described to two years, or even one year, as may be found advisable.

For the convenience of those already engaged in business, and of those from other causes prevented from entering for a longer period of study, it is arranged that they can attend a Course of Lectures upon any one subject of Applied Chemistry without being required to attend any other lectures, either in Applied Chemistry or in other subjects.

In the Session 1880-81, it is proposed to treat of the following subjects:—

(1) The Chemistry of the Alkali trade.
(2) Soap, Glass, Pottery, Cements.
(3) Agricultural Chemistry.
(4) Distilling, Vinegar-making, Bread- and Biscuit-making, or the Chemistry of Brewing.

Should a sufficient number of Students desire a Course of Lectures on some subject of Applied Chemistry other than those above mentioned, the Professor will give such either in lieu of, or in addition to, those mentioned.

Students desirous of working at subjects not included in the foregoing Courses, such as Photography and Photographic materials, Paper-making, Gas-tar products, the products of the Distillation of Wood, Tanning, and other Chemical industries, will receive individual instruction in the Laboratory.

Fees—for each Course, £2 2s.; for the four Courses together, £5 5s.

Chemical Laboratory.

The instruction in the Laboratory in Chemical Technology, will consist of the examination and valuation of raw materials used, and of the final products obtained, in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 2nd of October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

ROYAL SCHOOL OF MINES.

The mode of instruction at the Royal School of Mines is by systematic Courses of Lectures, by written and oral examinations, by practical teaching in the Laboratories, in the Drawing Office, and in the Field.

To become Associates at the Royal School of Mines it is necessary to pass through the following course of study:—

1st Year—Inorganic Chemistry, with practice in laboratory; Mechanical Drawing, both terms.

2nd Year—1st Term, Applied Mechanics; Physics, with practice in Laboratory. 2nd Term, Mineralogy; Mechanical Drawing, both terms.

3rd Year (Mining Division)—1st Term, Mining; Assaying. 2nd Term, Geology, with practice in laboratory and field. Metallurgical Division, 1st and 2nd Terms—Metallurgy, with practice in laboratory. Geological Division, 1st Term—Natural History, with practice in laboratory. 2nd Term—Geology, with practice in laboratory and field; Palæontological Demonstrations.

The courses of instruction are distributed over three years, but those students who possess sufficient knowledge may, if they think fit, pass through the whole in two years, by presenting themselves during the current year for examination in the subjects allotted to the first and second years.

Students desirous of obtaining the distinction of Associate of the Royal School of Mines, who have already acquired a knowledge of the subjects of the first two years, may proceed at once to the courses of the third year, by passing the first class examinations in those subjects before the Professors of the Royal School of Mines, and paying a fee of £1 for each examination.

During the Session 1879-80 the following courses of Lectures will be delivered:—

40 Lectures on Inorganic Chemistry, commencing Oct. 6, 1879; 30 Lectures on Organic Chemistry, commencing Jan. 19, 1880, by E. Frankland, F.R.S.

80 Lectures on Biology, by T. H. Huxley, LL.D., F.R.S., commencing Oct. 6, 1879.

36 Lectures on Applied Mechanics, by T. M. Goodeve, M.A., commencing Oct. 6, 1879.

60 Lectures on Physics, by F. Guthrie, F.R.S., commencing Nov. 17, 1879.

80 Lectures on Metallurgy, by J. Percy, M.D., F.R.S., commencing Oct. 20, 1879.

60 Lectures on Mining, commencing Nov. 10, 1879, and 40 Lectures on Mineralogy, commencing Feb. 23, 1879, by W. W. Smyth, M.A., F.R.S.

50 Lectures on Geology, by John W. Judd, F.R.S., commencing Feb. 23, 1880.

20 Lectures on Mechanical Drawing, by J. H. Edgar, M.A., commencing Oct. 11, 1879.

The Lectures on Chemistry, Physics, Mechanics, Biology, and Geology are delivered at the Science Schools, South Kensington, where instruction is also given in the Chemical, Physical, Biological, and Geological Laboratories. The Lectures on Mineralogy, Mining, Metallurgy, and Mechanical Drawing are given at the School of Mines in Jermyn Street, where the Metallurgical Laboratory is situated.

The Laboratories for instruction in chemical manipulation, in qualitative and quantitative analysis, the technical application of analysis, and in the method of performing chemical researches, are under the direction of Dr. Frankland, and will be opened on Wednesday, October 1, 1879.

The charge for instruction in the Chemical Laboratory is £12 for three months, £9 for two months, and £5 for one month.

The Metallurgical Laboratory is conducted by Mr. R. Smith, under the direction of Dr. Percy, and is devoted to practical instruction in Metallurgy, especially in Assaying. The nature of this instruction will be adapted to the special requirements of the Student. It comprises:—Assaying in all its branches, especially of the more important metals, such as iron, copper, lead, tin, alloys of silver and gold, &c.; and the examination of ores and metallurgical products.

The ability of the Student to make trustworthy assays is in every case thoroughly tested; and no certificate of competency is given to a Student who has not furnished satisfactory proof that he is able to obtain accurate results.

The charge for instruction in the Metallurgical Laboratory is £15 for three months, £12 for two months, and £7 for one month.

Lectures to Working Men.—Short Courses of Lectures at suitable periods of the year are given in the evening to Working Men. These courses are systematic, and arranged so as to illustrate, within a period of two years, the principal subjects taught at the institution. Those for the ensuing Session include Geology, Metallurgy, Physics, and Biology.

The following Exhibitions, Scholarships, and Prizes are awarded in connection with the School:—

Nine Royal Exhibitions, each of £50 per annum, three of which are competed for annually at the May examinations of the Department of Science and Art.

Two Royal Scholarships of £15 each to the best students of the first year; and One Royal Scholarship of £25 to the best second year's student.

The Edward Forbes Medal and Prize for Biology and Palæontology; the De la Beche Medal for Mining; and the Murchison Medal and Prize for Geology.

The public will be admitted to the lectures on payment of £4 for each course of 40 or more lectures, and £3 for the course of 30 and under 40 lectures.

The fee for students desirous of becoming Associates is £30 in one sum on entrance, or two annual payments of £20 each. Students presenting themselves for re-examination must pay a fee of £1 for each subject.

Persons who have taken either a first or a second class certificate in the advanced stage in any subject in science at the examinations held by the Science and Art Department, and who show that they are *bona fide* Science Teachers, may attend the Day Lectures gratuitously, provided that they be examined in at least one subject, paying fee for such examination of £1 per course.

Perpetual Tickets are issued, which entitle the holder to attend all present and future courses of lectures upon payment of £40.

Officers of the Army and Navy, Her Majesty's Consular and Diplomatic Officers, Officers of the Crown at home or on furlough, and acting Mine Agents and Managers of Mines, are admitted to the Lectures at half the above charges.

UNIVERSITY OF ABERDEEN.

Professor of Chemistry.—J. S. Brazier, F.C.S.

I. *Systematic Course.*—The Lectures are delivered on the first five days of each week during the College session. They commence with the discussion of the General Principles of Chemical Philosophy, including the Atomic Theory and the Chemical Relations of Heat. The Non-metallic and Metallic Elements and their Compounds are fully treated of, together with their more important applications to the Arts. The latter part of the course is devoted to the subject of Organic Chemistry. Examinations are held at fixed periods during the Session. The fee is £3 3s.

II. *Practical Course.*—This course is given during the Summer Session. It is chiefly devoted to practice in Qualitative Analysis, with the view of enabling the Student to test unknown substances, poisons, the animal secretions, &c. The fee is £3 3s.

III. *Laboratory Pupils.*—The Chemical Laboratory is open during the College Session on the first five days in each week, from 10 a.m. till 3 p.m. The course of instruction is under the direction of the Professor of Chemistry and of the Teaching Assistant.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—E. A. Letts, Ph.D., F.R.S.E.
Lecturer.—W. W. J. Nicol, M.A.

Inorganic Chemistry.

Monday, Wednesday and Friday, 10 to 11.

This Course will be continued during the First and Second Terms, and will relate to Chemical Philosophy, the Chemistry of the Non-Metals, and the Chemistry of the Metals. Special attention will be given to the applications of Chemistry to the arts and manufactures. Tutorial Lectures will be given once a week by the Lecturer on those points in the course which require detailed explanation.

Fee for the Course, £4 4s.

For students who have paid Laboratory fees in the Session to the amount of £8 8s., this fee will be reduced to £3 3s.

Chemical Analysis.

A Course of about Twenty Lectures to be delivered during the First and Second Terms.

These lectures are recommended to all studying Practical Chemistry, and are intended to familiarise the student with the chief methods of Qualitative and Quantitative Analysis, and will partly take the form of demonstrations.

Organic Chemistry.

This Course will relate to the more important groups of the Carbon Compounds.

Fee, £2 2s. for this course alone; £5 5s. for this and the Winter Course together.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures.

Fees—

	6 Days a Week.	3 Days a Week.	2 Days a Week.
Per Session	18 gns.	10 gns.	7½ gns.
,, Two Terms ..	13 ,,	7½ ,,	5½ ,,
,, One Term ..	7 ,,	4 ,,	3 ,,
,, Month	3 ,,	2 ,,	1½ ,,

In order that Students may have an opportunity of acquiring some knowledge of Applied Chemistry, excursions to some of the Mines and Manufactories of the neighbourhood will be made once a fortnight (on Saturdays) during the Summer Term. They will be conducted by the Professor or by the Lecturer. Past or present Students of the College desirous of taking part in these excursions are invited to apply to the Professor of Chemistry at the commencement of the Summer Term.

Evening Lectures.

Lecturer.—W. W. J. Nicol, M.A.

Tuesday and Thursday, 8 to 9.

This course will consist of Two Lectures a week; they will be devoted to the consideration of the Principles of Chemistry and the Study of the chief Non-Metallic Elements. In treating of the various products under the latter heading special attention will be devoted to their applications in the Arts and Manufactures.

Fee, 8s. per Two Terms.

Practical Class.

Professor.—E. A. Letts, Ph.D.
Lecturer.—W. W. J. Nicol, M.A.

Wednesday and Friday, 7 to 9.

A Practical Class will be formed for instruction in Qualitative and Quantitative Analysis provided a sufficient number of Students enrol. The Fee for the course (extending over the first and second terms) will be £4 4s.

Scholarships.

The following College Scholarships, open to women as well as men, will be competed for in October:—

One Chemical Scholarship of the value of £25, tenable for one year.

Three General Scholarships of the value of £25, £15, and £10 respectively, tenable for one year.

Four Scholarships for Women offered by the Clifton Association for Promoting the Higher Education of Women, will also be competed for. Of these, two will be entrance Scholarships; that is, they will be open only to those women who have not already commenced systematic study at the College. The other two will be open to all women excepting past and present scholars. Each of the four will be of the value of £15, tenable for one year, at University College, Bristol. Two of them may be augmented up to the maxiumum sum of £50 each, should such aid be necessary.

The Chemical Scholarship will be awarded principally by the marks obtained in Chemistry; but in case the best Candidates in it are nearly equal, account will be taken of their marks in other subjects.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

CHEMICAL DEPARTMENT.

Lectures and Laboratory Instruction are given in Organic, Inorganic, and Analytical Chemistry.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—T. E. Thorpe, Ph.D., F.R.S., F.C.S.

Lecture Courses.

1. General Course on Inorganic and Organic Chemistry —Monday, Tuesday, Wednesday, and Thursday, at 4 p.m., from October to the end of March. Fee for the Course, £4 4s.

2. Lectures on Laboratory Practice and Chemical Calculations—Thursday, at 10 a.m., during the First and Second Series. Fee, £1 1s.

3. Lectures on the Chemistry of the Non-Metals—Saturday, at 12 a.m., during the First and Second Terms. Fee, 10s. 6d.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session—Students working six days per week, £17 17s.; four, £13 13s.; three £11 11s.; two, £8 8s.; one, £4 4s.

Class in Practical Chemistry, Saturday mornings, from 9 to 12, during First and Second Series. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Monday and Wednesday, from 9 to 11 a.m., from May to the end of July.

Evening Classes.

A Course of twenty Lectures by Prof. T. E. Thorpe, F.R.S., on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Fridays, at 8 p.m., beginning October 17. Fee, 10s. 6d.

A Course of Twenty Lectures by Mr. C. H. Bothamley on the Elements of Inorganic Chemistry (the Non-Metals) will be given during the first and second Terms, on Mondays, at 8 p.m., beginning Oct. 13.

Scholarships.

The Cavendish Scholarship. Value £50 per annum, tenable for one year. Awarded for investigations made by the Candidates in any branch of Natural Science taught in the College.

The Salt Scholarship. Value £20 per annum, tenable for two years.

Akroyd Entrance Scholarships. Value £25 per annum, tenable for three years. Intended for the encouragement of the study of Natural Science. One of these Scholarships will be awarded annually, if in the opinion of the Examiners any Candidate shall possess sufficient merit.

The Clothworkers' Company Scholarships. Four Scholarships, each of the value of £25 per annum, and tenable for one year. Each Scholar will be required to attend regularly the Lectures and Courses of instruction given in the First and Second Years' Course of the Department of Textile Industries at the discretion of the Instructor.

UNIVERSITY OF DURHAM.
COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—A. Freire-Marreco, M.A.
Demonstrator—J. T. Dunn, B.Sc.

Junior Division.—General Principles of Chemistry. History of the Non-Metallic Elements. History of the Metals and their more important Native and Artificial Compounds. Principles of Qualitative Analysis. Elements of Organic Chemistry. *Senior Division.*—Organic Chemistry. Elements of Applied Chemistry, including Chemical Mineralogy and Analysis.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Arrangements for Laboratory work in the evening and during vacation will be made.

The Session will commence on October 6.

Courses of Study.—Students will be distinguished into Regular and Occasional. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Occasional Students will attend such classes as they may select. Every candidate for admission as a regular student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Senior Examination of Persons not Members of the University, held in June.
2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science, will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises:—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Quantitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises:—Elements of Chemistry. Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of £15 each will be awarded in October next, to Candidates desirous of attending the first year course of study in the College.

Candidates must pass the entrance examination, and will, in addition, be examined in the following subjects:—Algebra, up to Quadratic Equations. Euclid, Books I., II., and III. And one of the following special subjects, to be selected by the Candidate:—Geology.—Text Book: Page's "Introductory Text Book." Heat.—Text Book: "Orme on Heat." Chemistry.—Text Book: Gill's "Chemistry for Schools," omitting chapters xiii., xvi., xx., and xxi. Natural History.—Text Book: Nicholson's "Elementary Text Book of Zoology," or Oliver's Elementary Botany, Part I.

Candidates must send their names to the Secretary, on or before the 27th of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, the 6th October.

Two similar Exhibitions will be awarded at the next examination of "Persons not members of the University," which will be held at Durham, and elsewhere, in June next, to those candidates who shall most distinguish themselves in subjects allied to Physical Science.

Scholarships.

T. Y. Hall Scholarship.—This Scholarship, of the yearly value of £20, tenable for three years by students attending two or more of the classes, will be awarded on the result of the first examination for the Associateship in Science.

Charles Mather Scholarship.—This Scholarship, of the yearly value of about £40, will be awarded on the result of the Final Examination for the Associateship in Science, and is tenable for one year from the time of obtaining the Associateship in Science, provided the Scholar continues his studies in the College to the satisfaction of the Professors.

Nathaniel Clark Scholarship.—This Scholarship, of the value of £15 for one year, will be awarded in October to that student who shall pass the First Examination for the Associateship in Science, and who shall be most distinguished in Chemistry and Geology. The Scholar will be required to attend the classes of Chemistry and Geology, so as to be qualified to take those subjects for the Final Examination for the Associateship in June next.

OWENS COLLEGE, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—H. E. Roscoe, B.A., Ph.D., F.R.S., F.C.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Demonstrators and Assistant Lecturers.—Mr. W. C. Williams, F.C.S., Mr. Thomas Carnelley, D.Sc., and Mr. J. B. Hannay, F.C.S.

Lecture Courses.

Systematic Chemistry.—Junior Class.—Tuesday, Thursday, and Saturday, from 9.30 to 10.30 a.m., during Michaelmas and Lent Terms. Comprising—(1) The laws of Chemical Combination; (2) a description of the physical and chemical properties and the mode of preparation of the Non-Metallic Elements and of their Compounds.

Senior Class.—Monday, Wednesday, and Friday, from 9.30 to 10.30 a.m., during the Michaelmas and Lent Terms, comprising—(1) The Chemistry of the Metals and of their most important Compounds; (2) Organic Chemistry.

The instruction in Systematic Chemistry is given by means (*a*) of Experimental Lectures and (*b*) of Tutorial Classes.

Fee—For each Class, £2 12s. 6d.; for both Classes, £4 14s. 6d.

A Tutorial Class, meeting in Sections, will also be held, which all members of the Junior and Senior Classes will be required to attend, unless specially exempted by the Principal and the Professor. Extra fee for this Class, 10s. 6d. This fee is not included in the composition fees payable by regular Students.

Organic Chemistry.—Professor C. Schorlemmer, F.R.S., Monday, Wednesday, and Friday, from 10.30 to 11.30 a.m.

General Course (from October to the end of March).—The subject of this course is the Chemistry of the Carbon Compounds, wherein the branch of Organic Chemistry is more fully and completely treated than in the general course in Systematic Chemistry.

Extended Course (from the beginning of April to the end of the Session).—This course is suited to the requirements of students preparing for the B.Sc. examination and for those who have previously attended the general course and wish to become more intimately acquainted with the subject. The course will treat of the History of the Old and New Theories, and of the most recent important discoveries in Organic Chemistry, &c.

Fee for the General Course, £2 12s. 6d.; for the Extended Course, £1 11s. 6d.; for both Courses, £3 10s.

Chemical Philosophy.—Prof. C. Schorlemmer, F.R.S., Saturday, from 9.30 to 10.30 a.m.

Sketch of the History of Chemistry; Development of Modern Chemistry; Chemical Law and Theories; Relation of Chemistry to Physics.

Fee, £1 11s. 6d.

Technological Chemistry.—Dr. Carnelly will give in the Michaelmas and Lent Terms a Course of about Twenty Lectures, on Mondays, from 2.30 to 3.30 p.m., on Water, Air, and the Chemistry of Fuel and the Gas Manufacture.

Fee, £1 1s.

Analytical Chemistry.—Mr. W. C. Williams, F.C.S. Thursday, from 10.30 to 11.30 a.m.

This Course will treat of the methods of Qualitative and Quantitative Analysis, and is intended to supplement the instruction in Practical Chemistry.

Fee, £1 11s. 6d.

Analytical and Practical Chemistry.

LABORATORY COURSES.

The Chemical Laboratories will be open for Students daily from 9.30 a.m. until 4.30 p.m., except on Saturdays, when they will be closed at 12.30 p.m.

Fees for the Session—For six days per week, £21; for four days per week, £17 17s.; for three days per week, £13 13s. Students entering the Laboratory Class at or after Christmas will be charged two-thirds of the fees for the whole Session.

Fees for shorter periods—For six months, £17 17s.; for five months, £15 15s.; for four months, £13 13s.; for three months, £10 10s.; for two months, £7 7s.; for one month, £4 4s. Students entering under this scale are entitled to work on every day during the week.

The Metallurgical Laboratory will be open daily during the same hours as those of the Chemical Laboratories, for instruction in Practical Assaying and the examination of Ores and Metallurgical products.

Fees the same as those for the Chemical Laboratory Course.

A Course of Lectures on Metallurgy will probably be given in the course of the session if a sufficient number o students offer themselves.

Entrance Exhibitions.

I. Victoria Exhibition (Classics), £15.

II. Wellington Exhibition (Greek Testament), £15.

III. Dalton Mathematical Exhibition, £15.

The Victoria and Dalton Exhibitions are renewable for a second year.

IV. Grammar School Scholarships, £15 per annum, tenable for three years; open to scholars of the Manchester Grammar School only.

V. Two Oxford and Two Cambridge Local Exhibitions, giving free admission to lecture classes in the College for one year, and renewable for two years further are awarded annually on the results of the Oxford and Cambridge Examinations held in Manchester.

VI. Gilchrist Scholarship, £50 per annum, tenable for three years; awarded on the results of the Matriculation Examination of the University of London, in June, 1879.

VII. Rumney Scholarships, £45 per annum, tenable for three years. The next competition will take place in 1880.

VIII. Ramsbottom Scholarship, £40 per annum, tenable for two years. The next competition will take place in 1880.

IX. Crace-Calvert Scholarships, £25 per annum, tenable for two years. The next competition will take place in June, 1880. This scholarship is open only to duly qualified members of the Evening Chemistry Classes.

Fellowship.

The Langton Fellowship, £150 per annum, tenable for three years. Candidates must have been students in the College for not less than three sessions, and must during their studentship or within one year after the close of the same have obtained a degree of some University of the United Kingdom, or been elected to the Associateship of the College. The next competition for the Fellowship will take place in 1881.

Scholarships.

The following (except the Shakspere Scholarship) are open to the competition of students of the College only.

I. Victoria Scholarship (Classics), £40 per annum, tenable for two years.

II. Wellington Scholarship (Greek Testament), £20 per annum, tenable for two years.

III. Shuttleworth (Political Economy), £50, tenable for one year.

IV. Shakspere Scholarship (English Language and Literature), £40 per annum, tenable for two years.

V. Bradford History Scholarship, £45 per annum, tenable for one year, and renewable for a second year.

VI. Dalton Chemical Scholarships, two, each of £50 per annum, tenable for two years.

VII. Dalton Mathematical Scholarships, one Senior and one Junior Scholarship, of the value of £25 each, tenable for one year.

VIII. Platt Scholarships (Physiology), two, each of £50 per annum, tenable for two years.

IX. Heginbottom Physical Scholarship, £20 per annum, tenable for two years.

X. Ashbury Scholarships (Engineering), two, each of £25 per annum, tenable for two years.

Prizes.

I. Lee Greek Testament Prizes, one of £25 and one of £12 10s. value.

II. Classical Prizes, value £5. Junior Classical Prizes, value £5 and £2 10s.

III. Shuttleworth History Prize, value £5.

IV. English Essay and Poem Prizes, each of the value of £5.

V. Early English Text Society's Prizes.—A selection of the Society's publications offered to the competition of students in the Day and in the Evening Classes respectively.

VI. New Shakspere Society's Book Prizes.

VII. Bryce Law Prize, value £10.

VIII. Cobden Club Book Prizes (Political Economy).

IX. Dalton Natural History Prize, value £15.

X. Engineering Essay Prize, value £5.

ROYAL COLLEGE OF SCIENCE FOR IRELAND,

Stephen's Green, Dublin.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each, with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.E.
Chief Assistant.—M. T. Buchanan.
Lecture Assistant.—Robert Lennox.
Junior Assistants.—James M. Bowie and George A. Barling.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10 to 11, commencing about the end of October. The Lectures up to the end of the year are devoted to the elements of Chemical Philosophy and to the Chemistry of the Non-metallic Elements. After the new year the Course divides into two branches, viz., the Chemistry of the Metals (on the Mondays and Tuesdays) and Organic Chemistry, select chapters (on the Wednesdays, Thursdays, and Fridays). Six written examinations are held during the Session, which all the members of the class are required to attend. Fee, £2 2s.

A Course of Tutorial Lessons in connection with the above Lectures will be given by one of the Assistants. Free to the members of the class.

The Laboratory for Practical Instruction in all branches of analysis, including technical assaying, and for original research is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9 to 5. The teaching is conducted on the tutorial system, each student working by himself and on his own subject. The Laboratory is furnished with all the necessaries for chemical investigation.

Fee for the Winter Session, £10 10s.; Summer Session, £6 6s.; two sessions, if paid in advance, £15 15s., or £2 2s. per month.

THE

"YOUNG" CHAIR OF TECHNICAL CHEMISTRY, ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.
Senior Assistant.—Mr. J. Snodgrass.
Junior Assistant.—Mr. J. Bicket.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

Lectures.—*Principal Course.*—A Course of Fifty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 3rd. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. The earlier Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results. A particular subject will then be considered in comparatively minute detail, embracing for this session Coal-Gas: the concluding lectures will have special reference to Lubricating Oils.

Fee for the Course, Two Guineas. To Laboratory Students, One Guinea.

Subsidiary Course.—A Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 9 a.m., commencing in May. These Lectures are more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry.

Fee for the Course, Two Guineas.

Technical Physical Chemistry.—Mr. J. Snodgrass, Senior Assistant, has arranged to deliver a series of Thirty Lectures and Demonstrations on Chemical Apparatus.

Fee for the Course, Half-a-Guinea. Laboratory Students, Half-a-crown.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings, immediately contiguous to the site formerly occupied, are now erected and in order for occupation. They comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, have included in the arrangements Five Private Laboratories, which will, it is expected, meet a demand hitherto unsupplied in this country.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

Memorandum as to Bursaries.

The Trustees of the "Young" Chair have the superintendence of the Bursaries—regulating the appointment and terms on which they shall continue to be held.

The Nominees of Donors to be appointed if they pass the necessary examinations.

The Bursaries are of the amount of £50 each per annum, tenable for three years, during which the Bursars shall be required to give their whole time and attention to the Lectures and Laboratory duties of the "Young" Chair, paying the ordinary fees. Candidates to have attained sixteen years of age on application, to be of good moral character, and to pass such examinations as may be prescribed by the Trustees in the ordinary branches of an English education and the elementary principles of Chemistry. The Bursaries to be liable to forfeiture on the Bursars failing to exhibit approved progress under the Professor of the Chair, or being guilty of conduct, in the opinion of the Trustees, unworthy of their position. The Bursaries are only given to those whose means are limited, and who intend following some branch of Manufacturing Chemistry.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

Crystal Palace Company's School of Art, Science, and Literature. School of Practical Engineering. *Principal*—Mr. J. W. Wilson, Assoc. Inst. C.E.—This school was established with the purpose of affording to Students of Civil or of Mechanical Engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The leading object is to prepare Students, by systematic practical instruction, for professional articles, so that on entering an Engineer's office or works the pupil may at once be useful to his Principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession. The school is also available for Students already articled, who desire instruction either in the offices or shops. The Colonial Section is designed particularly for gentlemen who are going to the Colonies or abroad, as explorers or settlers. The object proposed is to afford them so much practical knowledge of scientific and mechanical work and expedients as shall enable them best to utilise the means at their disposal, especially when entirely dependent on their own resources.

Special Courses of Lectures are delivered by independent Lecturers not on the Staff of the School, and are an addendum to the curriculum. These Special Courses include a Course of Six Lectures on the Chemistry of Manufactures and Mines; and a Course of Six Lectures on the Mechanics of Practical Mining.

Ladies' Division.—The School was established to utilise the valuable Courts and Collections of the Crystal Palace for the purposes of instruction in Art, Science, &c., so that education of the highest class might be afforded on reasonable terms under most advantageous conditions. The system of tuition is, for some subjects, in the manner of private tutorial instruction by the best masters, but other subjects are taught on the University method, in accordance with the regulations laid down by the Syndicate of the University of Cambridge, by whom some of the lectures and classes are conducted. A student may take lessons in one or several studies at option. The School is a centre for both the University of Oxford and the University of Cambridge Local Examinations, the Oxford Examination for Women, and for the Cambridge Higher Local Examination. The following examinations will be holden in the Ladies' Division during 1879-80:—Cambridge Local, December, 1879; Oxford Local and Oxford Examination, for Women, May, 1880; Cambridge Higher Examination, June 1880. The session opens on October 1.

The Courses of Lectures during the ensuing term will include one on National Geography, on Mondays, by Prof. H. G. Seeley, F.R.S. Fees: Twelve Lectures and Classes, £1 1s. Twelve Lectures, 10s. 6d. One Lecture, 1s.

Berners College of Chemistry and the Experimental Sciences, 44, Berners Street, W.—Prof. E. V. Gardner, F.A.S., M.S.A. The Laboratory is open morning and evening throughout the year.

Birkbeck Literary and Scientific Institution, Southampton Buildings, Chancery Lane.—Inorganic Chemistry. Lectures:—Elementary, Tuesdays, 8.30 to 9.30; Advanced, Saturdays, 7 to 8. Practice:—Elementary, Saturdays, 4 to 6; Advanced, Saturdays, 8 to 10. Teacher, Geo. Chaloner, F.C.S. Organic Chemistry:—Course of Thirty Lectures will be given on Tuesday evenings, at 7 o'clock, by Mr. H. Chapman Jones, F.C.S., commencing on October 7th. Practical Organic Chemistry:—This Class will meet in the Laboratory of the Institution, under Mr. Chapman Jones's direction, on Saturdays from 4 to 6 and from 8 to 10 p.m.

New Central School of Chemistry and Pharmacy, 173, Marylebone Road, London.—Mr. A. P. Luff, F.C.S., and Mr. J. Woodland, M.P.S.

Onslow College of Science, Pond Place, Fulham Road, S.W.—Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical Laboratory is open on Friday Evenings from 6 to 10 p.m. and on Saturday from 2 to 10 p.m.

Royal Veterinary College, Camden Town.—Professor of Chemistry, Mr. R. V. Tuson.

School of Pharmacy of the Pharmaceutical Society of Great Britain, 17, Bloomsbury Square.—The school opens on Wednesday, the 1st of October. Lectures on Chemistry and Pharmacy, by Professor Redwood, on Monday, Tuesday, and Wednesday mornings, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment, synthetical as well as analytical. They are specially designed for the student of Pharmacy, but are also well adapted for the acquirements of a knowledge of Chemistry in its application to Manufactures, Analysis, and Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. We have in previous Students' Numbers drawn attention to the fact that the Professors strongly advise all learners, both before and during attendance at the school, to avoid studying merely by way of "preparation for examination." The one desire should be *education*, that is knowledge accompanied by enlightenment of the understanding, mental training, mental discipline, and general elevation of the intellect. As for "examination," students of the School may rest assured that if they, guided by the Professors, work diligently, thoughtfully, deliberately, and thoroughly, they will with ease and pleasure pass any examination in the subjects in which they have thus been truly educated.

Council Prizes.—At the end of each of the five months' Courses of Lectures on Chemistry and Pharmacy, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, the Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session only.

South London School of Chemistry, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 10 a.m. Sixty Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

The Westminster College of Chemistry and Pharmacy, Lambeth Road, S.E.—Messrs. Wills and Wootton. Daily, at 9.30 a.m. Theoretical and Practical Chemistry.

Working Men's College, 91, Blackfriars' Road.—Teacher of Chemistry, Mr. J. D. Allen.

CHEMICAL LECTURES AT LONDON HOSPITALS.

Chemical Schools and Colleges.	Winter Session.						Summer Session.					
	Lectures on Chemistry.	Days and Hours.	Fees.				Lectures on Chemistry.	Days and Hours.	Fees.			
			One Course.		Perpetual.				One Course.		Perpetual.	
			£	s.	£	s.			£	s.	£	s.
St. Bartholomew's Hosp. and College	Dr. Russell, F.R.S.	M. W. F., 9	6	16/6	9	9	Dr. Russell	M. Tu. F., 11 [to 1	3	3		
Charing Cross Hospital and College	Mr. Heaton	M. W. F., 11	5	5			Mr. Heaton	M. W.	3	3		
St. George's Hospital ..	Mr. Wanklyn	Tu. Th. S., 11½	7	7			Mr. Wanklyn	M. W. Th. F.	4	4		
Guy's Hospital	Dr. Debus, F.R.S., and Dr. Stevenson	Tu. Th. S., 11	7	7			Dr. Debus	M. W. F., 10 to 1	7	7		
King's College and Hosp.	Mr. Bloxam, F.C.S., Mr. Thomson, and Mr. Johnson	M. W. Th., 10¼	8	8	11	11	Mr. Bloxam and Mr. Hartley, & Mr. Thomson	M. W. Th., 10¼	6	6	8	8
London Hospital	Dr. Tidy	M. Tu. W. Th., 11	7	7	7	7	Dr. Tidy	M. Th. S., 9	2	2		
St. Mary's Hospital ..	Dr. Wright	M. W. Th., 4	6	16/6			Dr. Wright	W. F. S.	4	4		
Middlesex Hospital ..	Mr. W. Foster	M.W.Th.Fr.,9	6	6	8	8	Mr. W. Foster	M. W. F., 3	3	3		
St. Thomas's Hosp. & Schl.	Dr. Bernays	Tu. Th, F., 10	7	7			Dr. Bernays	M. Th. F., 10	6	6		
University Col. & Hosp.	Dr. Williamson, F.R.S. and Dr. Graham	Daily (ex. S.) 11	7	7	9	9	Dr. Williamson & Dr. Graham	Daily (ex. S.) 11	4	4	7	7
Westminster Hospital ..	Dr. Dupré, F.R.S.	W. Th. F., 3	6	6			Dr. A. Dupré	M. W. F., 10	4	4		

BIRMINGHAM.—MIDLAND INSTITUTE.—Mr. C. J. Woodward, B.Sc. Tuesday and Thursday, at 8 p.m.; Friday, at 7; and Saturday, at 3.

BIRMINGHAM.—QUEEN'S COLLEGE.—Mr. A. Bostock Hill, M.D.

BRISTOL MEDICAL SCHOOL.—Mr. T. Coomber, F.C.S.

LIVERPOOL ROYAL INFIRMARY SCHOOL OF MEDICINE.—J. Campbell Brown, D.Sc. Lond., F.C.S.

SCHOOL OF TECHNICAL CHEMISTRY, 7 and 9, Hackin's Hey, Liverpool.—Mr. A. Norman Tate.

COLLEGE OF CHEMISTRY, LIVERPOOL — Mr. S. H. Johnson, F.C.S.

LEEDS SCHOOL OF MEDICINE.—Prof. T. E. Thorpe, Ph.D., F.R.S.

LEEDS MECHANICS' INSTITUTION.—Mr. G. Ward, F.C.S.

MANCHESTER GRAMMAR SCHOOL.—Mr. Francis Jones, F.C.S., F.R.S.E.

MANCHESTER MECHANICS' INSTITUTION.—Mr. M. A. Watts, M.A.

QUEENWOOD COLLEGE, near Stockbridge, Hants.—Mr. E. W. Prevost, Ph.D., F.C.S., F.R.S.E.

SALFORD WORKING MEN'S COLLEGE, EVENING CLASSES.—Teacher of Chemistry, Mr. G. H. Hurst.

SHEFFIELD BOROUGH ANALYSTS' LABORATORY, 1 and 3, Surrey Street. — Mr. A. H. Allen, F.C.S. Day and Evening Classes.

SHEFFIELD SCHOOL OF MEDICINE.—Mr. A. H. Allen, F.C.S. A course of forty-five Lectures on Inorganic and Organic Chemistry is delivered by Mr. Alfred H. Allen during the Winter session. The Summer Course of Practical Chemistry is under the direction of Mr. A. H. Allen.

ABERDEEN SCHOOL OF SCIENCE AND ART MECHANICS' INSTITUTION.—Mr. Thomas Jamieson, F.C.S.

DUNDEE LITERARY INSTITUTION CHEMICAL AND PHYSICAL LABORATORY.—Lecturer on Chemistry, Mr. Frank W. Young, F.C.S., and Mr. John Thomson.

UNIVERSITY OF EDINBURGH.—Prof. A. Crum Brown, F.R.S.E.

SCHOOL OF MEDICINE, EDINBURGH.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, and Mr. Ivison Macadam.

SCHOOL OF PHARMACY AND CHEMISTRY, EDINBURGH.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Chemistry, Mr. Drinkwater, F.C.S., L.R.C.P.; Materia Medica and Pharmacy, Dr. Urquhart; Botany, Mr. D. M'Alpine, B.Sc. Lond. Day and Evening Classes.

MINTO HOUSE MEDICAL SCHOOL, CHAMBERS STREET, EDINBURGH.—Lectures and Classes.

GLASGOW UNIVERSITY.—Prof. J. Ferguson.

GLASGOW MECHANICS' INSTITUTION.—Mr. R. R. Tatlock, F.R.S.E., F.C.S.

GLASGOW VETERINARY COLLEGE.—Mr. Stephen Cooke, F.C.S.

SCHOOL OF CHEMISTRY, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

CHEMICAL LABORATORY, 144, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

ANALYTICAL LABORATORY, 88, Hope Street, Glasgow.—Dr. A. T. Machattie, F.C.S. Day and Evening Classes.

QUEEN'S COLLEGE, BELFAST.—Dr. Andrews, F.R.S., &c.

QUEEN'S COLLEGE, CORK.—Dr. Maxwell Simpson.

QUEEN'S COLLEGE, GALWAY.—Dr. T. H. Rowney.

ROYAL COLLEGE OF SURGEONS IN IRELAND.—Dr. C. A. Cameron.

DUBLIN, CARMICHAEL SCHOOL.—Dr. C. R. C. Tichborne.

DUBLIN, CATHOLIC UNIVERSITY.—Mr. Campbell.

DUBLIN, DR. STEEVENS'S HOSPITAL AND MEDICAL COLLEGE.—Mr. McHugh.

ON TWO NEW ELEMENTS IN ERBIA.

By P. T. CLÈVE.

TOWARDS the end of last year M. Marignac discovered in erbia, which, up to that time, had been considered as the oxide of a single metal, erbium, the oxide of a new element very strongly characterised, viz., ytterbia. A short time afterwards M. Nilson found in erbia another oxide, scandia, the salts of which are as colourless as those of ytterbia. The substance which gives to the salts of erbia their red colouration and magnificent absorption spectrum, that is to say true erbia, is still unknown. I resolved to extract if possible from the old erbia this colouring principle. I had at my disposal a considerable quantity of material, almost entirely free from ytterbia. M. Nilson was so good as to give me the residues of the extraction of scandia and ytterbia. I found, however, even after hundreds of separations, that it was imposible to obtain a red oxide of constant molecular weight. I was therefore led to suppose the presence of another unknown oxide, and I asked M. Thalén to examine the absorption spectrum of the fraction that I regarded as pure erbia, and at the same time to compare its spectrum with the spectra of the residues rich in ytterbia and yttria. Some absorption bands in the last fractions suggested the idea that the colour of erbia is occasioned by the presence of three oxides in the absorption spectrum. I then re-united the reddest fractions, the molecular weight of which was from 126 to 127 (RO), and submitted them to a long series of decompositions, treating one fraction (A) for ytterbia, another (B) for yttria, and an intermediary third, in which true erbia ought to be concentrated. At the same time I tried to concentrate the colouring-matter in the residues rich in ytterbia (A) and in yttria (B). When I had exhausted the material at my disposal I asked M. Thalén to kindly examine the five fractions. This examination led to the following results:—

For the examination of absorption spectra of the five given fractions, the liquid was enclosed in a glass trough with parallel sides of a thickness of 0·008 m., or in test-tubes of about 0·010 m. diameter. In order to obtain sufficient, but very different dispersions, I employed for each of the fractions, sometimes two, sometimes six flint prisms, whose angle of refraction was 60°. The registration is referred to the solar spectrum, and the positions of the absorption bands relate to Angström's normal spectrum of the sun. The figures below express the wave-lengths in 100,000ths.

The absorption bands common to all the fractions, which bands must probably be attributed to erbia, are as follow:—

Colour of Rays.	Wave-Length.	Remarks.
Red	6660—6680	Feeble
	6515—6545	Strong
	6475—6515	Tolerably strong
Yellow	5400—5415	,, ,,
Green	5225—5235	Very strong
	5185—5225	Strong
Blue	4865—4877	Strong
Indigo	4475—4515	Tolerably strong

A very marked difference is, however, observed between the following bands, according as they are examined with one or other of the liquids in question.

		Fraction A.			Fraction B.	
	Length of Wave.	From Residues of Ytterbia.	Erbia (126—127).	Erbium (?) Mean Fractions (126—127).	Erbia.	From Residues rich in Yttrium.
x	6840	Strong	Tolerably strong	None	None	None
y	6400—6425	None or trace only	Trace	Feeble	Feeble	Very strong
z	5360	None	None or trace	Trace	Feeble	Tolerably strong

It is then seen that the band x belongs to the fractions situated near to ytterbia, whilst it does not exist in the fractions derived from yttria. But it is quite the contrary with respect to the bands y and z; indeed, these bands, which are wanting altogether in the residues of ytterbia, show themselves more and more clearly as we approach yttria.

It follows from these researches that the spectrum of old erbia must be attributed to three distinct oxides. In fact, the colour of the solution of the different fractions materially differs. Whilst the fractions treated for ytterbia are of a rose colour with a tinge of violet, the fractions treated for yttria have an orange tinge. Although I possess considerable quantities of the mixture of these three oxides, I am convinced that it would be useless to continue these researches until I have been able to procure still larger quantities. For the radical of the oxide placed between ytterbia and erbia, which is characterised by the band x in the red part of the spectrum, I propose the name of *Thullium*, derived from Thulé, the ancient name of Scandinavia. The atomic weight Tm of this metal must be about 113 (its oxide being RO); at least its oxide is found concentrated in the fractions which have for their molecular weight 129. The atomic weight of true erbium, to which the common bands are to be attributed, is probably from 110 to 111. Its oxide is of a light rose colour.

The third metal characterised by the bands y and z, and which is found between erbia and terbia, must have a lower atomic weight than 108. Its oxide appears to be yellow; at least, all the fractions of a molecular weight lower than 126 are more or less yellow. I propose for this metal the name of *Holmium*, Ho, derived from the latinized name of Stockholm, in the neighbourhood of which so many minerals rich in yttria are to be found.

It only remains for me to express my gratitude to M. Thalén for the trouble he has taken in all these researches.

Referring to the above communication of M. Clève, Prof. J. Lawrence Smith made the following observations:—

I have latterly had the opportunity of conversing with several of the *savants* who are occupying themselves in the study of the earths of the yttrium and cerium group. Notwithstanding the interesting results they have already obtained, they still have more or less doubt as to the clearness of those results, and the conclusion which may be deduced from them on account of the difficulty of separating these earths one from the other.

Attention ought to be directed as much as possible towards the purification of the earths, as until they can be obtained pure only their relative position among the elements can be indicated. How far the impurities modify the absorption rays, whether in the luminous or in the ultra-violet part of the spectrum, is still an open question. The earth with which I have specially occupied myself—oxide of mosandrum—does not give absorption rays, and I am obliged to study it chemically, and I think I have obtained it in a tolerably pure state, but not sufficiently so to satisfy me. I may say that it is more insoluble in sulphate of potash than the terbia of Mosander. I have already indicated, moreover, some other special properties. With respect to the absorption rays of earths, I should call the attention of the Academy to a note by M. Lecoq de Boisbaudran and myself (*Comptes Rendus*, vol. lxxxviii., p. 1167, in which we have shown how in an easy and complete manner some of the rays of didymium can be changed.—*Comptes Rendus*, September 1, 1879.

NOTES ON THE ALKALOIDS.
A NEW TEST FOR PAPAVERINE.

By J. TATTERSALL.

Papaverine when brought in contact with concentrated sulphuric acid gives a light pink-violet colour. On heating this either disappears completely, or becomes a light grey, but the following reaction is more permanent and more characteristic of the alkaloid:—

Place the substance to be tested for papaverine in an evaporating basin, add a few drops of concentrated H_2SO_4, and warm till complete solution is effected. Now add a fragment of sodium arsenate, and warm again over a small flame, inclining the dish to obtain as large a surface of liquid as possible. The original colour once more makes its appearance, but on continued application of heat it becomes cherry-red, and finally, as vapours of sulphuric acid begin to escape, dark bluish-violet. This colouration is very stable. When the contents of the dish are quite cold, add about 10 c.c. of water, and pour the orange liquid obtained into a flask, dilute once more, and add caustic soda to strongly alkaline reaction; the liquid rapidly darkens in colour, and when an excess has been added appears almost black; it is violet-red by reflected, and a pink straw colour by transmitted, light. The alkaloids strychnine, brucine, morphine, salicine, atropine, narcotine, narceine, digitaline, picrotoxine, curarine, colchicine, and cantharidine do not exhibit this reaction, becoming, on subsequent addition of alkali, light orange or dirty yellow.

Codeine, when heated with concentrated H_2SO_4 and Na_3AsO_4, gives a fine deep blue colour, much darker than the one produced by Fe_2Cl_6 under similar circumstances. On addition of water and alkali this becomes orange, and is characteristic of the alkaloid.

Hayfield Printing Co., Hayfield.

ON RADIANT MATTER.*

By WILLIAM CROOKES, F.R.S.

(Concluded from page 107.)

Radiant Matter is deflected by a Magnet.

I NOW pass to another property of Radiant Matter. This long glass tube (Fig. 14), is very highly exhausted; it has a negative pole at one end (*a*) and a long phosphorescent screen (*b*, *c*) down the centre of the tube. In front of the negative pole is a plate of mica (*b*, *d*) with a hole (*e*) in it, and the result is, when I turn on the current, a line of phosphorescent light (*e*, *f*) is projected along the whole length of the tube. I now place beneath the tube a powerful horseshoe magnet: observe how the line of light (*e*, *g*) becomes curved under the magnetic influence waving about like a flexible wand as I move the magnet to and fro.

Fig. 14.

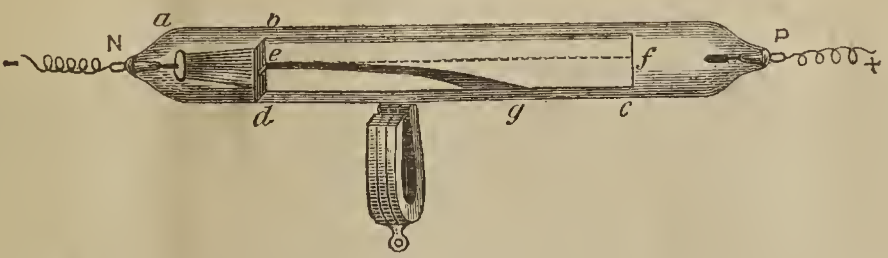
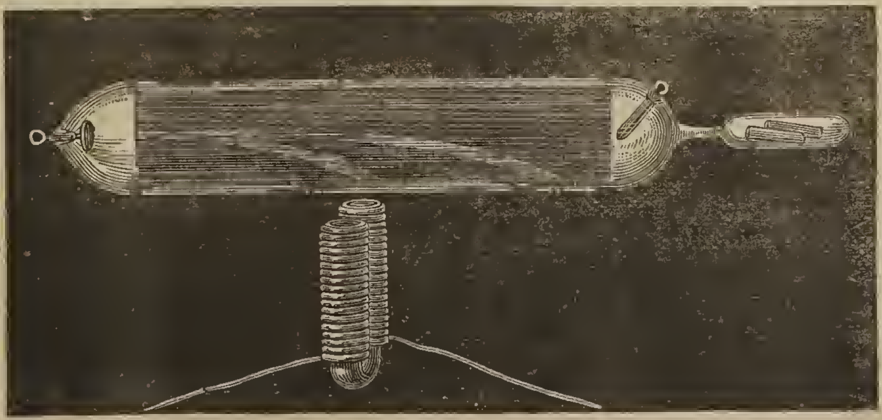


Fig. 15.



This action of the magnet is very curious, and if carefully followed up will elucidate other properties of Radiant Matter. Here (Fig. 15) is an exactly similar tube, but having at one end a small potash tube, which if heated will slightly injure the vacuum. I turn on the induction current, and you see the ray of Radiant Matter tracing its trajectory in a curved line along the screen, under the influence of the horse-shoe magnet beneath. Observe the shape of the curve. The molecules shot from the negative pole may be likened to a discharge of iron bullets from a mitrailleuse, and the magnet beneath will represent the earth curving the trajectory of the shot by gravitation. Here on this luminous screen you see the curved trajectory of the shot accurately traced. Now suppose the deflecting force to remain constant, the curve traced by the projectile varies with the velocity. If I put more powder in the gun the velocity will be greater and the trajectory flatter, and if I interpose a denser resisting medium between the gun and the target, I diminish the velocity of the shot, and thereby cause it to move in a greater curve and come to the ground sooner. I cannot well increase before you the velocity of my stream of radiant molecules by putting more powder in my battery, but I will try and make them suffer greater resistance in their flight from one end of the tube to the other. I heat the caustic potash with a spirit-lamp and so throw in a trace more gas. Instantly the stream of Radiant Matter responds. Its velocity is impeded, the magnetism has longer time on which to act on the individual molecules, the trajectory gets more and more curved, until, instead of shooting nearly to the end of the tube, my molecular bullets fall to the bottom before they have got more than half-way.

It is of great interest to ascertain whether the law governing the magnetic deflection of the trajectory of Radiant Matter is the same as has been found to hold good at a lower vacuum. The experiments I have just shown you were with a very high vacuum. Here is a tube with a low vacuum (Fig. 16). When I turn on the induction spark, it passes as a narrow line of violet light joining the two poles. Underneath I have a powerful electro-magnet. I make contact with the magnet, and the line of light dips in the centre towards the magnet. I reverse the poles, and the line is driven up to the top of the tube. Notice the difference between the two phenomena. Here the action is temporary. The dip takes place under

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* A Lecture delivered to the British Association for the Advancement of Science, at Sheffield, Friday, August 22, 1879

the magnetic influence; the line of discharge then rises and pursues its path to the positive pole. In the high exhaustion, however, after the stream of Radiant Matter had dipped to the magnet it did not recover itself, but continued its path in the altered direction.

By means of this little wheel, skilfully constructed by Mr. Gimingham, I am able to show the magnetic deflection in the electric lantern. The apparatus is shown in this diagram (Fig. 17). The negative pole (*a*, *b*) is in the form of a very shallow cup. In front of the cup is a mica screen (*c*, *d*), wide enough to intercept the Radiant Matter coming from the negative pole. Behind this screen is a mica wheel (*e*, *f*) with a series of vanes, making a sort of paddle-wheel. So arranged, the molecular rays from the pole *a b* will be cut off from the wheel, and will not produce any movement. I now put a magnet, *g*, over the tube, so as to deflect the stream over or under the obstacle *c d*, and the result will be rapid motion in one or the other direction, according to the way the magnet is turned. I throw the image of the apparatus on the screen. The spiral lines painted on the wheel show which way it turns. I arrange the magnet to draw the molecular stream so as to beat against the upper vanes, and the wheel revolves rapidly as if it were an over-shot water-wheel. I turn the magnet so as to drive the Radiant Matter underneath; the wheel slackens speed, stops, and then begins to rotate the other way, like an under-shot water-wheel. This can be repeated as often as I reverse the position of the magnet.

FIG. 16.

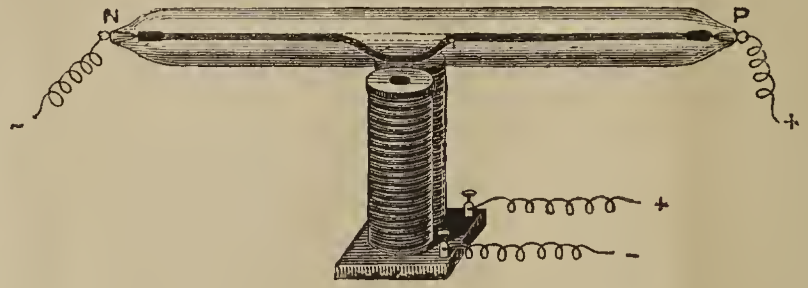


FIG. 17.

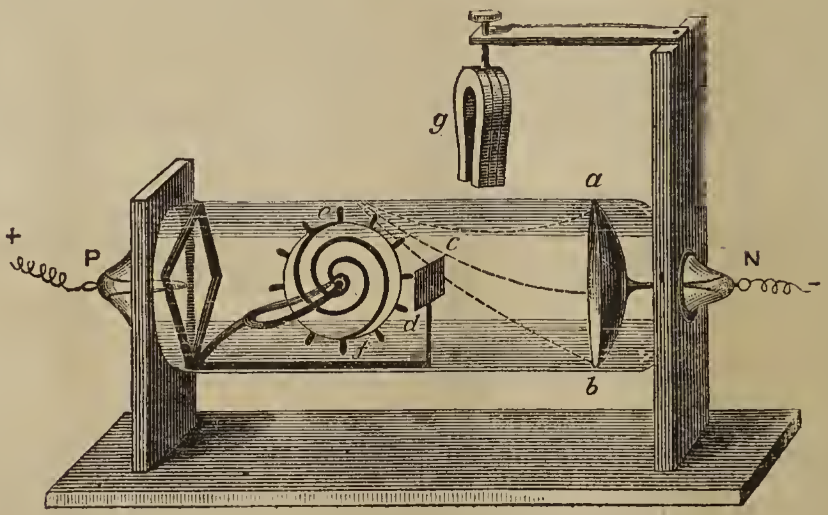
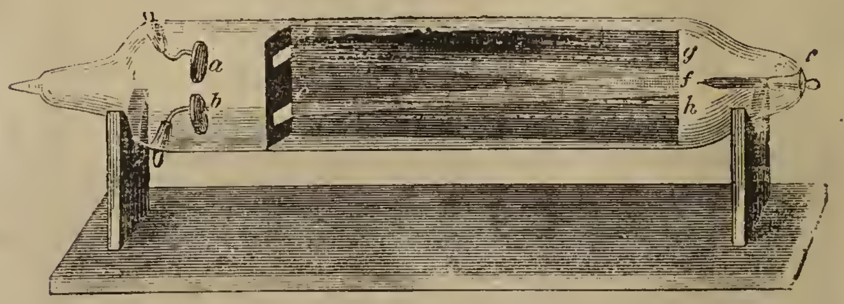


FIG. 18.



I have mentioned that the molecules of the Radiant Matter discharged from the negative pole are negatively electrified. It is probable that their velocity is owing to the mutual repulsion between the similarly electrified pole and the molecules. In less high vacua, such as you saw a few minutes ago (Fig. 16), the discharge passes from one pole to another, carrying an electric current, as if it were a flexible wire. Now it is of great interest to ascertain if the stream of Radiant Matter from the negative pole also carries a current. Here (Fig. 18) is an apparatus which will decide the question at once. The tube contains two negative terminals (*a*, *b*) close together at one end, and one positive terminal (*c*) at the other. This enables me to send two streams of Radiant Matter side by side along the phosphorescent screen,—or by disconnecting one negative pole, only one stream.

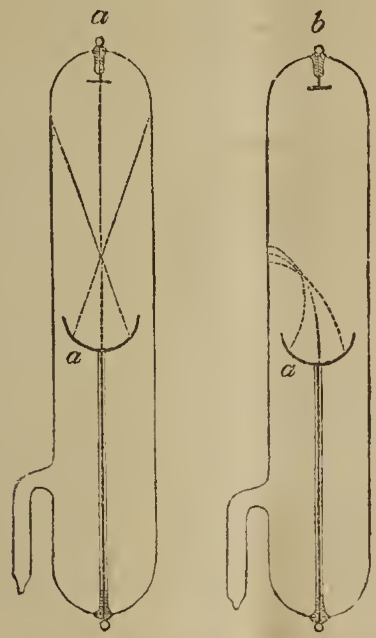
If the streams of Radiant Matter carry an electric current they will act like two parallel conducting wires and attract one another; but if they are simply built up of negatively electrified molecules they will repel each other.

I will first connect the upper negative pole (*a*) with the coil, and you see the ray shooting along the line *d*, *f*. I now bring the lower negative pole (*b*) into play, and another line (*e*, *h*) darts along the screen. But notice the way the first line behaves; it jumps up from its first position, *d f*, to *d g*, showing that it is repelled, and if time permitted I could show you that the lower ray is also deflected from its normal direction: therefore the two parallel streams of Radiant Matter exert mutual repulsion, acting not like current carriers, but merely as similarly electrified bodies.

Radiant Matter produces heat when its motion is arrested.

During these experiments another property of Radiant Matter has made itself evident, although I have not yet drawn attention to it. The glass gets very warm where the green phosphorescence is strongest. The molecular focus on the tube, which we saw earlier in the evening (Fig. 8) is intensely hot, and I have prepared an apparatus by which this heat at the focus can be rendered apparent to all present.

Fig. 19.

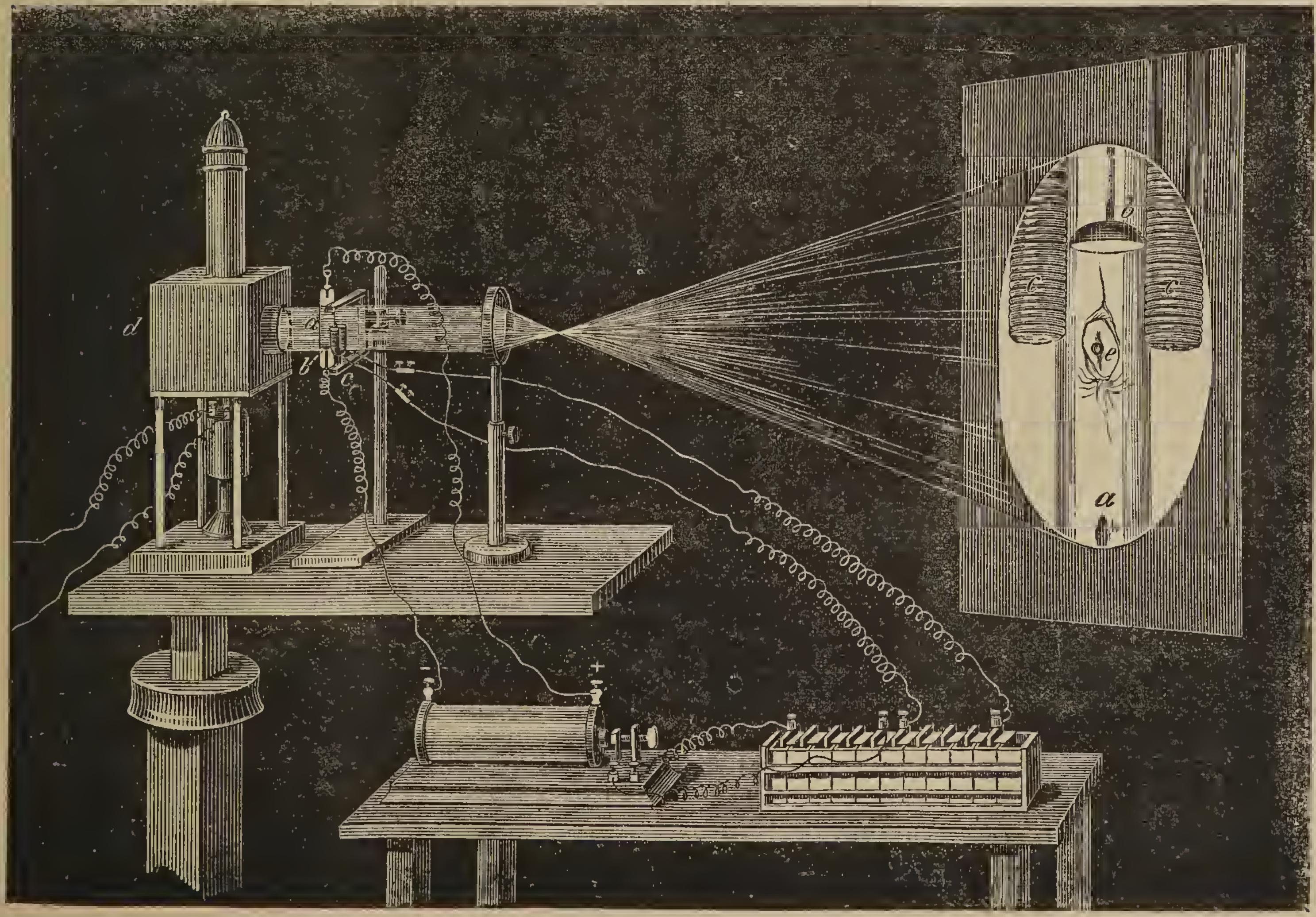


I have here a small tube (Fig. 19, *a*) with a cup-shaped negative pole. This cup projects the rays to a focus in the middle of the tube. At the side of the tube is a small electro-magnet, which I can set in action by touching a key, and the focus is then drawn to the side of the glass tube (Fig. 19, *b*). To show the first action of the heat I have coated the tube with wax. I will put the apparatus in front of the electric lantern (Fig. 20, *d*), and throw a magnified image of the tube on the screen. The coil is now at work, and the focus of molecular rays is projected along the tube. I turn the magnetism on, and draw the focus to the side of the glass. The first thing you see is a small circular patch melted in the coating of wax. The glass soon begins to disintegrate, and cracks are shooting starwise from the centre of heat. The glass is softening. Now the atmospheric pressure forces it in, and now it melts. A hole (*e*) is perforated in the middle, the air rushes in, and the experiment is at an end.

I can render this focal heat more evident if I allow it to play on a piece of metal. This bulb (Fig. 21) is furnished with a negative pole in the form of a cup (*a*). The rays will therefore be projected to a focus on a piece of iridio-platinum (*b*) supported in the centre of the bulb.

I first turn on the induction-coil slightly, so as not to bring out its full power. The focus is now playing on the metal, raising it to a white-heat. I bring a small magnet near, and you see I can deflect the focus of heat just as I did the luminous focus in the other tube. By shifting the magnet I can drive the focus up and down, or draw it completely away from the metal, and leave it non-luminous. I withdraw the magnet, and let the molecules have full play again; the metal is now white-hot. I

Fig. 20.



increase the intensity of the spark. The iridio-platinum glows with almost insupportable brilliancy, and at last melts.

Fig. 21.

The Chemistry of Radiant Matter.

As might be expected, the chemical distinctions between one kind of Radiant Matter and another at these high exhaustions are difficult to recognise. The physical properties I have been elucidating seem to be common to all matter at this low density. Whether the gas originally under experiment be hydrogen, carbonic acid, or atmospheric air, the phenomena of phosphorescence, shadows, magnetic deflection, &c., are identical, only they commence at different pressures. Other facts, however, show that at this low density the molecules retain their chemical characteristics. Thus by introducing into the tubes appropriate absorbents of residual gas, I can see that chemical attraction goes on long after the attenuation has reached the best stage for showing the phenomena now under illustration, and I am able by this means to carry the exhaustion to much higher degrees than I can get by mere pumping. Working with aqueous vapour I can use phosphoric anhydride as an absorbent; with carbonic acid, potash; with hydrogen, palladium; and with oxygen, carbon, and then potash. The highest vacuum I have yet succeeded in obtaining has been the 1-20,000,000th of an atmosphere, a degree which may be better understood if I say that it corresponds to about the hundredth of an inch in a barometric column three miles high.

It may be objected that it is hardly consistent to attach primary importance to the presence of *Matter*, when I have taken extraordinary pains to remove as much Matter as possible from these bulbs and these tubes, and have succeeded so far as to leave only about the one-millionth of an atmosphere in them. At its ordinary pressure the atmosphere is not very dense, and its recognition as a constituent of the world of Matter is quite a modern notion. It would seem that when divided by a million, so little Matter will necessarily be left that we may justifiably neglect the trifling residue and apply the term *vacuum* to space from which the air has been so nearly removed. To do so, however, would be a great error, attributable to our limited faculties being unable to grasp high numbers. It is generally taken for granted that when a number is divided by a million the quotient must necessarily be small, whereas it may happen that the original number is so large that its division by a million seems to make little impression on it. According to the best authorities, a bulb of the size of the one before you (13·5 centimetres in diameter) contains more than 1,000000,000000,000000,000000 (a quadrillion) molecules. Now, when exhausted to a millionth of an atmosphere we shall still have a trillion molecules left in the bulb—a number quite sufficient to justify me in speaking of the residue as *Matter*.

To suggest some idea of this vast number I take the exhausted bulb, and perforate it by a spark from the induction coil. The spark produces a hole of microscopical fineness, yet sufficient to allow molecules to penetrate and to destroy the vacuum. The inrush of air impinges against the vanes and sets them rotating after the manner of a windmill. Let us suppose the molecules to be of such a size that at every second of time a hundred millions could enter, How long, think you, would it take for this small vessel to get full of air? An hour? A day? A year? A century? Nay, almost an eternity! A time so enormous that imagination itself cannot grasp the reality. Supposing this exhausted glass bulb, indued with indestructibility, had been pierced at the birth of the solar system; supposing it to have been present when the earth was without form and void; supposing it to have borne witness to all the stupendous changes evolved during the full cycles of geologic time, to have seen the first living creature appear, and the last man disappear; supposing it to survive until the fulfilment of the mathematician's prediction that the Sun, the source of energy, four million centuries from its formation will ultimately become a burnt-out cinder;* supposing all this,—at the rate of filling I have just described, 100 million molecules a second—this little bulb even then would scarcely have admitted its full quadrillion of molecules.†

But what will you say if I tell yout that all these molecules, this quadrillion of molecules, will enter through the microscopic hole before you leave this room? The hole being unaltered in size, the number of molecules undiminished, this apparent paradox can only be explained by again supposing the size of the molecules to be diminished almost infinitely—so that instead of entering at the rate of 100 millions every second, they troop in at a rate of something like 300 trillions a second. I have done the sum, but figures when they mount so high cease to have any meaning, and such calculations are as futile as trying to count the drops in the ocean.

In studying this Fourth state of Matter we seem at length to have within our grasp and obedient to our control the little indivisible particles which with good warrant are supposed to constitute the physical basis of the universe. We have seen that in some of its properties Radiant Matter is as material as this table, whilst in other properties it almost assumes the character of Radiant Energy. We have actually touched the border land where Matter and Force seem to merge into one another, the shadowy realm between Known and Unknown which for me has always had peculiar temptations. I venture to think that the greatest scientific problems of the future

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* The possible duration of the Sun from formation to extinction has been variously estimated by different authorities, at from 18 million years to 400 million years. For the purpose of this illustration I have taken the highest estimate.

† According to Mr. Johnstone Stoney (*Philosophical Magazine*, vol. 36, p. 141), 1 c.c. of air contains about 1000,000000,000000,000000 molecules. Therefore a bulb 13·5 centims. diameter contains $13{\cdot}5^3 \times 0{\cdot}5236 \times 1000{,}000000{,}000000{,}000000$ or 1,288252,350000,000000,000000 molecules of air at the ordinary pressure. Therefore the bulb when exhausted to the millionth of an atmosphere contains 1,288252,350000,000000 molecules, leaving 1,288251,061747,650000,000000 molecules to enter through the perforation. At the rate of 100,000000 molecules a second, the time required for them all to enter will be

12882,510617,476500 seconds, or
214,708510,291275 minutes, or
3,578475,171521 hours, or
149103,132147 days, or
408,501731 years.

will find their solution in this Border Land, and even beyond; here, it seems to me, lie Ultimate Realities, subtle, far-reaching, wonderful.

> "Yet all these were, when no Man did them know,
> Yet have from wisest Ages hidden beene;
> And later Times thinges more unknown shall show.
> Why then should witlesse Man so much misweene,
> That nothing is, but that which he hath seene?"

NEW PROCESS FOR THE RAPID ESTIMATION OF PURE SUGAR IN RAW AND REFINED COMMERCIAL SUGARS.[*]

By P. CASAMAJOR.

(Concluded from page 108.)

Correction for Variations of Temperature.—When we operate at temperatures different from 15° C. or 60° F., the corrections can be made by using either of the tables of Gay-Lussac or those for the instrument of Tralles, which we owe to Prof. MacCulloch. I will, however, state that results that are sufficiently accurate may be obtained by proceeding as follows:—

For solutions which give, by the alcohometer from 77 to 70, we may multiply the excess of temperature above 60° F. by 0·2, and deduct the product from the reading of the alcohometer. For degrees of the alcohometer between 70 and 60, we may multiply this excess by 0·205, and for indications below 60° of the alcohometer, the excess of temperature above 60° F., must be multiplied by 0·21, and the product deducted. If a centigrade thermometer is used, the excess of temperature over 15° should be multiplied by 0·36 for solutions above 70° of the alcohometer. For solutions between 60° and 70° (alcohometer), the excess over 15° C. should be multiplied by 0·37, and for those below 60°, this excess should be multiplied by 0·38. In all cases, the product should be deducted from the direct reading of the alcohometer. The results obtained in this way do not differ materially from those given by the tables.

There is another correction for variation of temperature, which relates to the volume of standard solution to be taken for a weight of sugar equal to 19·8 gr. As the temperature rises, a greater volume of standard solution should be taken. If we use a Fahrenheit thermometer we take—

At 60° F.	.. ..	50·0 c.c. of standard solution.
,, 70	.. ..	50·3 ,, ,, ,,
,, 80	.. ..	50·6 ,, ,, ,,
,, 90	.. ..	51·0 ,, ,, ,,
,, 100	.. ..	51·3 ,, ,, ,,

If we use centigrade thermometer, we should take—

At 15° C.	.. ..	50·0 c.c. of standard solution.
,, 20	.. ..	50·25 ,, ,, ,,
,, 25	.. ..	50·5 ,, ,, ,,
,, 30	.. ..	50·8 ,, ,, ,,
,, 35	.. ..	51·2 ,, ,, ,,
,, 40	.. ..	51·4 ,, ,, ,,

If it should be preferred to use always the same volume of 50 c.c. of standard solution, we may take the following weights for the temperatures of a centigrade thermometer:

At 15° C.	.. .. ..	19·8 grammes.
,, 20	.. .. ..	19·7 ,,
,, 25	.. .. ..	19·6 ,,
,, 30	.. .. ..	19·5 ,,
,, 35	.. .. ..	19·4 ,,
,, 40	.. .. ..	19·3 ,,

In the following table may be found the same data concerning methylic alcohol of various strengths, saturated with sugar, as are given in table No. 1 for ethylic alcohol.

TABLE No. 4.

Degrees of the alcohometer before saturation.	Ditto after saturation with sugar.	Degree of the saccharometer (Ventzke).	Grms. of sugar in 100 c.c.
92·5	91·8	1·7	0·44
83·5	77·1	13·2	3·43
82·7	76·5	—	—
81·5	75·0	—	—

From this table we may learn that the solution, saturated with sugar, standing at 77·1 by the alcohometer, should, when placed in the saccharometer tube, stand at 13·2. We also learn that the same saturated solution must contain 3·43 grammes of sugar in 100 c.c. This is a useful guide for the quantity of extra powdered sugar that should be added to 1 litre of methylic alcohol of 83½°.[*]

Method of Procedure in Testing.—The sugar to be tested should not be weighed before everything is ready, as otherwise it may dry out, after being weighed, and give too high a result. The mortar and pestle should be clean and dry, the cylinder should be filled with the standard solution to a line indicating 50 c.c., and a clean dry funnel should be ready with a paper filter in it. The weight of sugar to be taken is 19·8 grammes. This is transferred to the mortar as soon as weighed, and the standard solution should be poured in the mortar, and the sugars then ground with a heavy pestle until all lumps and large crystals are broken up.[†]

The mortar I have used for grinding sugar in presence of the standard solution has a capacity of 180 c.c., and the pestle is of such a size that it displaces 80 c.c. in this mortar.

After all the lumps have been broken up the contents of the mortar are poured on a filter standing over the cylinder, which previously held the standard solution. As there was some of this solution left in the cylinder, about 10 c.c. of the filtered solution is allowed to run into the cylinder, after which the funnel is taken from the cylinder and held over the mortar long enough to shake up the liquid in the cylinder and pour it back on the filter. After this the funnel is placed again over the cylinder, the contents of the mortar are poured again on the filter, and from 30 to 35 c.c. are allowed to run through the filter, which are generally sufficient for a test. In this filtered solution are placed, in succession, an alcohometer and a thermometer. To the alcohometric degree, corrected for temperature, is added the difference between 100 and the alcohometric degree of the standard solution. This sum represents the percentage of sugar.

Example.—The standard solution gives with the alcohometer 76·8 when corrected for temperature. The same alcohometer placed in the filtered solution marks 71°, while a centigrade thermometer shows a temperature of 28°. According to what has been already said, we take the difference between 28 and 15 = 13, and multiply this

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[*] Read before the American Chemical Society, June 5, 1879.

[*] From this table we may also learn that if we apply methylic alcohol to Payen's process, we need have no fear of leaving in the sugar a small quantity of the solution made by saturating with sugar methylic alcohol at 92·5°. With ethylic alcohol, cane sugars are always left with too much impurity. Dr. Behr informs me that on this account he has never been able to obtain good results by this process. It is certainly worth while trying methylic alcohol. Cane sugars could be washed out with our standard solution, testing 77·1 (alcohometer), and the last particle of this could be removed by methylic alcohol 92·5, saturated with sugar. The small quantity of this latter remaining after filtration would leave too little sugar to cause an appreciable error. The funnel with auxiliary vertical tube, of which I gave a description several years ago, is very well adapted to washing sugars out with alcohol, as it leaves them quite dry without the help of a filter pump (see *American Chemist*, Oct., 1875, vol. vi., p. 122, and Chemical News, vol. xxxii., No. 829, p. 183).

[†] Persons who test raw centrifugal sugars by this process must very soon see what *artificially coloured sugars* consist in. This has been a vexatious question, occupying the attention of eminent chemists. By washing sugar crystals with alcohol we may easily see that in the grains of some of them have been incorporated brown insoluble particles. In some cases these look like the scum from the defecation of the juice, and, in other samples, the colouring matter seems to be clay or some brown pigment. This colouring matter seems generally to have been added in a very clumsy manner, as after washing the crystals in alcohol it may be seen in lumps, speckin, the crystals with dark dots.

difference by 0·36, the product being 4·68. This quantity subtracted from 71 gives 66·32. The difference between 100 and 76·8 being 23·2, this quantity is added to 66·32, and the sum, 89·52, is the quantity of pure sugar in the sugar tested.

It has been suggested that the evaporation of methylic alcohol during the manipulations that have been described must interfere with the accuracy of the results obtained, but this does not seem to be the case. It might be possible to avoid evaporation entirely by leaving out the operation of grinding the mixture of sugar and methylic alcohol in a mortar; but, in this case, the results obtained would be less accurate on account of the impurities left in the sugar. Beyond avoiding working in a draft, no precaution has been taken to prevent evaporation. One reason why the evaporation of the alcohol seems to have so little effect on the result is that the operation of grinding and filtering occupy only a few minutes, during which no appreciable loss takes place.

NOTICES OF BOOKS.

Catechism of Agricultural Chemistry and Geology. By the late J. F. W. Johnston. An entirely new edition, revised and enlarged by C. A. Cameron. 78th thousand. Blackwoods, 1879.

To revise an old established favourite like this little Catechism is no easy task. It is hard for an editor to leave out statements which may not precisely commend themselves to his judgment, but which he does not know how to replace by anything more certain. It is hard to keep to the old limits and yet to add the more important facts discovered by recent researches. It is hard to maintain in the new part a style which came quite naturally to the original author. To say that Dr. Cameron has succeeded perfectly in an operation where failure is so common would be incorrect. But the new editor has undoubtedly improved the book, as it has been issued since Dr. Voelcker's revision of the original text in 1863. He ought to have done more, however. The old tables on pages 34, 36, and 37 needed revision; those on page 53 should have been replaced by sets of figures representing the results of properly conducted field-experiments: it is of no service to any one to tell them that a certain number (8) of extra bushels of wheat-grain were obtained from an acre of land by the use of 4 cwts. of "wheat manure," unless the experiment were tried in duplicate at least, the composition of the manure given, and all the other conditions of the experiment, natural and artificial, duly recorded and discussed. And even then such information and such details cannot be profitably used by the young learners, for whom the little work under notice is intended. Figures drawn from a much wider range, as well as higher class of experimental trials, are necessary for them. We hope Dr. Cameron will go through the book again before the issue of the 79th thousand, and make a good many more corrections and additions. With the exception of one of the old tables having been expanded into six, and a few figures and statements having been slightly changed, we do not see any great revision or enlargement of the present edition.

A Systematic Course of Practical Qualitative Analysis. By T. Eltoft. Pp. vi. and 62. London: Simpkin, Marshall, and Co., 1879.

Although this pamphlet does not differ widely from other digests of qualitative chemical operations, it bears throughout distinct marks of having been compiled by an experienced teacher of analysis. If another book of this sort be wanted for students preparing for the Science and Art Department, Medical Schools, London University, and Oxford and Cambridge Local Examinations, Mr. Eltoft's work may prove useful: at least, it may be said to present some commendable features. But the effort after brevity and conciseness leads here, as elsewhere, to imperfections if not to errors. For instance, we do not see that any provision is made (pp. 25, 30, 53, and 55) for testing for fluorine when silicon is also present; the mode given for identifying oxalic acid is not conclusive; and the directions for removing, by means of sodium carbonate, heavy metals previous to testing for acids, are vague. A tabular statement of the general scheme of analysis for bases is omitted, although the substance of such a scheme is given in a less advantageous shape. Mr. Eltoft claims originality for the table of processes to be used in detecting acids (page 53), but we fail to see novelty in it. The Table of Solubilities, on page 9, does not strike us as very clear—indeed the 2nd section of it appears misleading.

Elements of Modern Chemistry. By A. Wurtz. Translated and Edited by W. H. Greene, M.D. Pp. 687. London and Philadelphia, 1879.

Still another manual of chemistry for students! We confess to having experienced some degree of disappointment on perusing this recent addition to the crowd of similar digests of chemical facts and theories. The great reputation of M. Wurtz, and the popularity of the original work in France, led us to expect a volume perfect as far as it went in its scope and in its selection and treatment of details. No doubt the philosophical or theoretical aspect of chemical science is fairly handled in these pages, but of the descriptive part of the work we find it impossible to speak in terms of equal praise. We object to the non-metals being called (p. 3) "metalloids"; we object to the statement (p. 7) that the objects around us present "*infinite* differences": when we look up particular elements and compounds, one after another, in order to test the lateness of the information given and the judgment shown in its selection and arrangement, we find old data and statements cited as if they were still of real value; we fail to discover that perfection of orderly arrangement which a systematic treatise, however compact, should always exhibit; and we here oftentimes search, in vain, for a notice of the most salient features and most characteristic data of the bodies described. One would imagine, for instance, that the specific gravity and hardness of such an important substance as rock-crystal would be given (p. 199—200), and that we should be spared such an inane remark as this, "chalcedony, onyx, and opal are sought for by the lapidary and engraver." One would expect, too, that more recent information about graphite would be furnished to us than the imperfect, half-obsolete, and partially incorrect statements of pages 201 and 202; surely, the existence of graphitic acid might have been noted. Reaching the metals, we do not fare much better. Under potassium (p. 282) the explanation offered to account for the explosive violence with which, when the metal burns on water, the resulting fused potassium hydrate is suddenly quenched and dissolved, includes no reference to the spheroidal state. Sodium hydrate, we are informed (p. 292), "is known in commerce as concentrated lye." Bleaching powder, according to the equation on p. 309, is made with anhydrous lime: we would ask how much chloride of lime is now manufactured in the manner described and figured (fig. 101) by M. Wurtz? On page 302, the author assigns to Lamy the honour, not only of establishing the metallic nature of thallium, but of first isolating that element. It seems to us impossible that any unprejudiced and well-informed chemist could honestly deny to Crookes the credit of having discovered thallium, and also of having first made known its metallic nature and first publicly exhibited it. Let any one who doubts this conclusion read the *Philosophical Magazine* for July, 1863. He will then find that Mr. Crookes exhibited thallium in the International Exhibition of 1862, on May 1st, duly labelling his case with the words "Thallium, a new metallic element, discovered by means of spectrum analysis." The individual specimens of metallic thallium and its salts were there shown with labels which were proved to have been printed on the 25th of April, 1862. And what publication of Crookes's discovery could have been more conspicuous and incontrovertible than the exhibition of a series of duly labelled specimens to an immense concourse of visitors on an occasion like that of the opening of the Exhibition on May 1st, 1862?

We have not space to discuss the remainder of this book; the organic section especially would require more attention than we can give it here. But it appears from casual dips which we have taken into the latter part of this "Introduction to Modern Chemistry," that the new carbon compounds therein described are treated more satisfactorily than the older and more familiar ones. For instance, the description of malting and the figure of a sprouted barley grain, given on page 579, hardly commend themselves to the critical faculty. Cellulose when pure has a definite specific gravity, not one oscillating (p. 585) between 1·25 and 1·45; *Charpie*, too (pp. 585 and 586), has an English equivalent; and we were not aware that collodion was a solution of *tri*nitrocellulose. Considering the paramount importance of chlorophyll in organic nature, we might at least expect one line about its occurrence and function. But, in fact, the details of this work do not bear the kind of scrutiny which one has a right to apply to a book written by Wurtz.

CORRESPONDENCE.

NEW ELEMENTS.

To the Editor of the Chemical News.

Sir,—The number of "new elements" announced in successive numbers of the Chemical News is really appalling. During the past two years no less than eleven claimants for recognition as elemetary substances have presented themselves. With your permission we will call the roll, and inspect briefly the chemical recruits.

List of New Elements and their Discoverers.

1877, June	Davyum	Sergius Kern.
,, ,,	Neptunium	Hermann.
,, ,,	Lavoesium	Prat.
,, May	Mosandrum	J. L. Smith.
1878, Sept.	"New earths"	Gerland.
,, Oct.	Philippium	Delafontaine.
,, Nov.	Ytterbium	Marignac
,, Nov.	Decipium	Delafontaine.
1879, March	Scandium	Nilson.
,, July	Norwegium	Dahll.
,, Aug.	Uralium	Guyard.

Now, while several names in this formidable list are doubtless destined to stand the test of time, the majority, I opine, will have to join the noble army of "defunct elements." Probably only the "fittest" will "survive."

Seriously, however, have we not a right to hesitate before accepting these claimants and granting them a place in our catalogue of elements. To put a practical question, How long shall we delay before mentioning these substances in the instruction of advanced classes? Shall we enter them in our text-books? Who will undertake to say that one chemist is thoroughly reliable, and that another is economical of truth or easily deceived? What authority is weighty enough to settle the existence or non-existence of these bodies?

These and similar thoughts doubtless occur to many. We would like to see the views of some of your correspondents on this knotty problem.—I am, &c.,

Sceptical Chymist.

The Chemistry of Food.—A course of ten lectures on the Chemistry of Food will be delivered at the National Training School for Cookery, Exhibition-road, South Kensington, by Prof. Church. The lectures will be given on Mondays at 5 p.m., the course beginning on Monday next, the 15th instant.

MISCELLANEOUS.

Action of Pyrogallate of Potassa upon Binoxide of Nitrogen.—G. Lechartier.—The binoxide of nitrogen seems to undergo a decomposition, giving rise, on the one hand, to protoxide of nitrogen, and, on the other, to the more highly oxidised compounds, nitric and nitrous acids, whose action upon the pyrogallate of potassa is already known.—*Comptes Rendus.*

Synchronism of the Mean Temperature and Rainfall in the Climate of London.—Mr. H. Courtenay Fox, M.R.C.S., of Stoke Newington, read a paper on this subject before the British Association at the Sheffield meeting. The paper was accompanied by copious tables exhibiting the months and seasons for sixty-seven years, arranged in the order of their respective temperature and rainfall as for the Royal Observatory. The following is a short summary of the results:—1. In each of the four months from November to February, extreme cold tends to be synchronous with dryness, warmth with large rainfall. 2. In the summer months, June to August, cold tends to be accompanied by much rain, warmth by dryness. 3. To put this in popular language, rain brings warmth in winter and cold in summer; that is (if rain be the cause, which is by no means proven) it mitigates the special character of each extreme season, winter and summer. 4. Very wet years tend to be either cold or warm, whilst years of drought tend to assume an average temperature.

TO CORRESPONDENTS.

W. S. S. G.—There is no process by which the odour can be removed from nitrobenzol.

Veraz.—They are artificial ethers. A knowledge of manufacturing chemistry is required for their preparation. The names and mode of preparation are given in most hand-books of chemistry.

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THE CHEMICAL NEWS.

VOL. XL. No. 1034.

ON THE PRESENCE OF NITROGEN-IN STEEL.*

By ALFRED H. ALLEN, F.I.C., F.C.S.

THE author made some preliminary experiments on this subject in 1872, but has only recently obtained any definite results. The method adopted has been to dissolve the steel in hydrochloric acid, by which means any combined nitrogen may be presumed to be converted into ammonia. The solution obtained was then distilled with excess of lime, and the distillate examined for ammonia by Nessler's method. The employment of this extremely delicate test enabled the author to operate on a much smaller quantity of steel than was employed by previous investigators. Very special precautions were taken to obtain the hydrochloric acid and other materials free from any trace of ammonia or nitrous compounds, and the air was entirely expelled from the apparatus before commencing the operation. The hydrogen evolved was freed from any traces of ammonia by passing it through a tube filled with glass beads moistened with hydrochloric acid. It was proved by blank experiments that no source of ammonia existed in the reagents or apparatus.

When absolutely pure materials were used, and every precaution taken to get rid of the contained air and other sources of error, the addition of Nessler's solution to the liquid obtained on distilling with lime caused a very marked yellowish brown colouration. On comparing the tint produced with that yielded by a dilute solution of ammonium chloride of known strength, results were arrived at representing the proportions of nitrogen present in various typical specimens of steel.

As the results obtained from steels of different kinds varied greatly, it cannot be assumed that there was a constant source of error in the mode of manipulation; while as the same samples gave substantially concordant results on repeating the experiment, the figures obtained are not the result of accident, but are true expressions of the proportions of nitrogen present.

In order to obtain ammonia in quantity sufficient for its recognition by other reactions than that with Nessler's test, the following plan was employed.

Steam, generated by boiling water in a flask, was passed over a considerable quantity of steel borings contained in a combustion-tube which was bent beyond the furnace, and prolonged so as to form the inner tube of a Liebig's condenser. To the further end, a tube filled with glass beads and furnished with a glass stop-cock was attached. A rapid current of steam was driven through the apparatus for a considerable time to expel every trace of air. On condensing the steam, it was found free from any trace of ammonia. The steel borings were then heated to redness by a combustion furnace, and a rapid current of water passed through the condenser. The condensed steam, when tested by Nessler's solution, was found to contain abundance of ammonia, which did not diminish in amount till the borings were almost entirely oxidised. On re-distilling the condensed steam, a distillate was obtained, having a distinctly alkaline reaction to litmus paper, and on treating it with hydrochloric acid and platinic chloride a sensible amount of yellow precipitate was obtained, having the characteristic crystalline form of ammonium chloroplatinate. The amount found was larger than could possibly have been produced had the whole of the nitrogen of any residual trace of air been converted into ammonia.

The author regards the results now recorded as preliminary merely, and proposes to extend the research to various classes of steel and iron, and especially to such specimens as have been found to possess anomalous characters. Of these characters, the evolution of ammonia from freshly fractured surfaces is among the most striking.

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* Abstract of a paper read before the British Association for the Advancement of Science (Section B.), Sheffield, 1879.

A HISTORICAL SKETCH OF VAPOUR-DENSITY METHODS.*

By JAS. T. BROWN, F.C.S.

ALTHOUGH Southern in 1803 made some very careful determinations on steam, still the first accurate method was that of Gay-Lussac, who, in 1811, heated a weighed quantity of substance over mercury in a graduated vessel. In 1822, Cagniard de la Tour studied the combined effect of heat and pressure on various liquids, but Despretz, in the same year, worked on vapours in exhausted globes of 9 litres capacity. In 1826, Dumas, wishing to operate on substances which attack mercury, worked out and published his well-known method, in which the *volume* is definite but the amount of substance used has to be determined. In 1833, Mitscherlich proposed using tubes, sealed at one end and drawn to a neck at the other, instead of bulbs, and gave details and drawings of the apparatus for heating them. Bineau, in 1838, published an elaborate paper, but unfortunately without any drawings; in 1846 he repeated the experiments of Despretz with slight modifications. In 1849, Regnault used an apparatus very similar to that of Mitscherlich, but closed the air-thermometer tube by means of a stop-cock. Bineau, in 1859, for high temperatures, used glass tubes coated with clay; but Regnault, in 1861, to obtain the same result, used iron tubes, and heated them in a revolving cast-iron tube over gas-burners. Another method of Regnault's was to employ cast-iron bottles with loose stoppers, and to use the vapour of mercury as the standard instead of air. In 1866, Grabowski used the original Dumas method, but for air-thermometer employed a globe of the *same* size as that containing the substance. Bunsen, in 1867, employed an air-bath similar to that of Mitscherlich, but heated it by an elaborate arrangement of gas-burners. For high temperatures Deville and Troost, in 1860, heated the bulbs in the vapour of mercury, sulphur, zinc, or cadmium; above the boiling-point of sulphur they used porcelain globes. For temperatures up to that point the smaller apparatus devised by Greville Williams answers admirably. Roscoe, last year, used porcelain globes and heated them in a muffle, but determined the temperature by the method of specific heat. For working at a reduced pressure Regnault proposed partially exhausting the bulb during the experiment; in 1876, Habermann (whose method was referred to by Sommaruga) gave a diagram of the complete apparatus. The main point in Playfair and Wanklyn's method (1861) of vapours mixed with air, consisted in stopping the supply of vapour before the bath had attained its maximum temperature.

Natanson, in 1855, to work up to 300°, heated the upper part of the Gay-Lussac tube in an air-bath by means of charcoal; he used Avogadro's tables for the tension of mercury vapour. In Greville Williams's (1857) apparatus for working at various pressures, the metallic cistern, by which communication was made between the bottom of the graduated tube and the bottom of the open tube, was small, so that the whole arrangement could be placed in the water- or oil-bath. In Regnault's apparatus for the same purpose the two tubes are fastened to the bottom of the water-bath, and are connected underneath by a T-piece. For ordinary determinations up to 150°, Greville Williams proposed standing the graduated tube in a small iron cup

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* Abstract of a paper read before the British Association for the Advancement of Science (Section B.), Sheffield, 1879.

containing mercury, and supporting it in a glass vessel resembling a large test-tube. Schiff, in 1862, proposed fastening a loaded handle to the upper extremity of the graduated tube by spring clips. Grabowski, in 1866, heated the tube in an air-bath by means of gas, and placed an exactly similar tube containing air by the side of the substance-tube, so that the comparison could be made direct between the vapour and air under the same conditions. Croullebois, in 1874, proposed using a tube with a large globe at the end, but Deville criticised his method rather severely.

In 1868, Hofmann adopted a tube more than 760 m.m. in length, and enclosed it in a slightly larger mantle tube. He then passed the vapour of a liquid of definite boiling-point through the intervening space, selecting the liquid according to the temperature required. He thus maintained a steady temperature with the greatest ease. Wichelhaus, in 1870, fitted a modified U-tube to the bottom of the graduated tube, so that the whole of it could be surrounded by vapour. Grabowski, in 1875, used naphthalen with Hofmann's apparatus, but Engler, in the following year, to avoid the occasional stoppage of the outlet-tube, fitted to the lower end of the outer tube a short side tube, similar to those used for heating funnels. He then boiled the heating medium in this tube and allowed the vapour to cohobate in the space between the two glass tubes. Hofmann, at the same time, proposed making the outer tube long enough to enter the mercury in the trough, and placed the outlet a short distance above the mercury-level. He also proposed using plain tubes instead of graduated, by marking the height of the column by a gummed label and then measuring the volume occupied by the vapour. His third proposal was to place the inlet and outlet both at the bottom of the outer tube, so that during the heating of the liquid in the boiler, a portion of it could be forced at will into the space between the two glass tubes so as to heat them more gradually.

Brühl used an inner tube 1·5 m. in length, and to eliminate the tension of mercury vapour heated the column to the required temperature, noted the height, allowed it to cool, introduced the substance, and then heated again to the same temperature. He also made a mark on the tube a little above the vacuum mercury-level, and then only calibrated about 150 m.m. down from that point. Muir and Suguira, in 1877, ensured communication between the mercury in the tube and that in the trough by means of a short piece of glass tubing bent at right angles, which passed through the india-rubber disc on which the tubes rested. A second tube long enough to stand slighly above the level of the mercury in the trough served as outlet from the space between the two tubes. Brühl has this year proved by most carefully conducted experiments that the Hofmann method cannot be used above 220°, cwing to the great and rapidly increasing vapour-tension of mercury. Of the overflow methods, the first is that of Hofmann, who, in 1860, wrote that he used an U-tube heated in a paraffin bath, and estimated the volume of the vapour by the mercury expelled. Wertheim (1862-4) gave full details of his method, in which he used two short tubes suspended in a flask. Watts, in 1867, employed a globe with a ground neck into which an outlet tube reaching nearly to the bottom of the globe was accurately fitted. Victor Meyer, in 1876, used fusible metal and placed the outlet at the bottom of the bulb. His experiments were all made in the vapour of boiling sulphur, but Graebe last year used phosphorus pentasulphide. Frerichs, in 1876, used an inverted flask and brought the outlet through the bottom of the bath. Goldschmiedt and Ciamician, in 1877, used mercury with the simpler bulb of V. Meyer, but added a small side tube to the outlet, so that the mercury expelled could be weighed during the heating. V. Meyer, in the same year, modified the shape of the bulb, but heated it in a tube of sufficient length for the upper part to serve as condenser. Pfaundler's method (1870 and 1879) is based on the increased tension of the air, in an elongated bulb, produced by heating after the introduction of the substance, as compared with a similar determination on air in a bulb of the same size. A very short description appeared in 1874 of a method by Dulong on the same principle. Last year Hofmann proposed (1) to heat the weighed substance over mercury in the closed limb of an U-tube, and to calculate the volume from the extent to which heating caused the mercury to rise in the open limb; (2) to heat a limited but weighed quantity of substance in an exhausted tube, and to calculate the volume of the vapour from the amount of air which entered the tube to restore equilibrium while at the maximum temperature. V. and C. Meyer's method, which is so recent and so well known as not to require any explanation, is based on the measurement under atmospheric conditions of the air expelled by the vapour, the substance being introduced *after* the bulb has been heated.

THE PHYSICAL PROPERTIES OF LIQUID ACETYLEN.*

By GERRARD ANSDELL, F.C.S.,
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The hydrocarbon acetylen, being the only one of its numerous class which can be formed synthetically by the direct union of its constituent elements, has an especial interest for the chemist. The chief physical constants of this substance are unknown, although its polymerised modification, benzene, has been very thoroughly studied in its physical relations by Regnault. Having one of M. Cailletet's ingenious pumps for the liquefaction of gases at my disposal in the laboratory of the Royal Institution, Professor Dewar suggested a series of accurate determinations of its physical properties in the liquid state, and the present communication deals with the critical point, the tension of the vapour of the fluid at various temperatures, together with the corresponding densities and coefficients of compressibility.

The only notice on the liquefaction of the gas appears to be a short paper by M. Cailletet in the *Comptes Rendus*, vol. lxxxv., No. 19, in which he determines the tension of the vapour of the liquid at different temperatures. These tensions, as will be afterwards seen, differ entirely from those obtained in the present paper, one of the reasons appearing to be that instead of using a carefully calibrated air manometer for determining the pressures, he used the ordinary metallic gauge attached to the pump, which is far from being correct.

The pump itself is too well known to need description; suffice it to say that two of the iron bottles or reservoirs were used, connected with the pump by a piece of fine-bore copper tubing, so as to equalise the pressure, one containing an air manometer registering the pressures from ten atmospheres upwards, and the other the tube filled with acetylen. The two bottles were then placed by side, and the height of the column of mercury in either read off by means of a cathetometer.

The formulæ used for calibrating the tubes, and also for calculating the volume of the liquefied gas, and the pressure by the air manometer, were those given by Dr. Andrews in his researches on carbonic acid (*Phil. Trans.*, 1869 and 1876). The method of preparing the acetylen gas was by the action of alcoholic potash on bibromethylen, the disengaged gas being collected in the form of the red acetylide of copper, by passing it into a strong solution of subchloride of copper in ammonia. This red compound, after being thoroughly washed and boiled with distilled water, was transferred to a flask with dilute hydrochloric acid, the gas driven off by means of a gentle heat, and conducted through a strong solution of caustic soda, to free it from traces of hydrochloric acid, and finally

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* Read before the British Association for the Advancement of Science (Section B.), Sheffield, 1879.

through two small U-tubes with fused chloride of calcium. The perfectly pure and dry acetylen was now passed through the tube to be used for its liquefaction in a slow stream for several hours, and the latter carefully sealed off when all the air had been expelled.

The sealing off requires great care, as unless rapidly done, and the pressure removed from the inside (by cooling the tube) immediately the point is closed, the acetylen becomes rapidly charred and blows out, a small portion of it being consequently decomposed, and thus interfering materially with the accuracy of the results.

The tube for the tension determinations was of the usual shape used in the Cailletet pump, the internal diameter of the capillary part being about 2·5 m.m. This was found to be more convenient than a narrower tube, as a larger reservoir could be used, and consequently a larger quantity of liquid obtained.

The pressure at the different temperatures was always observed when a very slight layer of liquid was formed on the surface of the mercury, as the gas not being entirely free from air, the pressure was slightly increased on filling completely the upper part of the tube.

The following are the tensions obtained compared with those of Cailletet:—

		Cailletet.	
Temp.	Pressure.	Temp.	Pressure.
−23·00° C.	11·01 atm.		
−10·00	17·06 ,,		
0·00	21·53 ,,	+ 1·0° C.	48 atm.
+ 5·25	25·48 ,,	2·5	50 ,,
13·50	32·77 ,,	10·0	63 ,,
20·15	39·76 ,,	18·0	83 ,,
27·55	48·99 ,,	25·0	94 ,,
31·60	56·20 ,,	31·0	103 ,,
36·00	65·36 ,,		
36·50	65·89 ,,		
36·90	67·96 ,,		

The temperatures above zero were kept constant to within $\frac{1}{20}$th of a degree by allowing a constant stream of water to flow over the tube from a reservoir holding about 10 gallons, in which it had been previously thoroughly mixed. The temperature of −10° was obtained by cooling down alcohol with ice and salt, and that at −23° by surrounding the tube with a narrow glass cylinder containing liquid chloride of methyl, which boils constantly at this temperature; this cylinder being again enclosed in a wider one containing a little phosphoric anhydride to prevent moisture from condensing on the sides.

It was thought interesting to compare the tensions of liquid acetylen with those of the saturated vapour of benzene, being polymeric bodies, although having totally different properties. For this purpose curves were plotted for the two substances, that for the benzene being taken from Regnault's results (*Mem. Acad. Sci., Paris*, vol. xxvi., p. 420). They do not, however, run parallel to each other, the benzene having a slower rate of increase at low temperatures, but a quicker rate than the acetylen as the temperature rises. The curves, however, have no appearance of actually crossing at a higher temperature.

The critical point of acetylen, or that temperature at which no appearance of liquefaction takes place, however great a pressure is exerted on the gas, was found after many careful experiments to be 37·05° C.

For determining the density and compressibility of the liquid at different temperatures a tube of much smaller dimensions was used, having a capillary bore of about 0·8 m.m. in diameter, the whole of the tube having a capacity of 36·3708 c.c. This gave a column of liquid about 15 centims. long when the upper part of the tube was entirely full at 15° C.

The density at any particular temperature was taken by forcing the liquid up the capillary tube at that temperature until the upper part was completely filled. The length of the column of liquid was then read off, its volume calculated, and this observed volume divided into the calculated weight of the gas at zero. They are as follows:—

Temp.	Density.
− 7·00° C.	0·460
− 3·00	0·456
0·00	0·451
+ 4·40	0·441
9·00	0·432
16·40	0·420
20·60	0·413
26·25	0·404
30·00	0·397
34·00	0·381
35·80	0·364

It has, therefore, about half the density of liquid carbonic acid, and if we take the actual volume of the liquid at −7 as unity, it becomes 1·264 at +35·8, which gives 0·00489 as its coefficient of expansion per degree for the total range of pressure; it is, therefore, only about half as expansible as carbonic acid, whose coefficient is 0·010, and is not much more expansible than a gas. Comparing the density of liquid acetylen with that of liquid benzene, the latter is found to be almost exactly three times as great as the former at the same temperature; as, for instance, at 0° C. the density of the acetylen is 0·456, whereas that of the benzene is 0·899. The vapour-density, however, of the benzene is three times as great, viz., 2·704.

The apparent compressibility in glass was determined by direct observation, the liquid being forced up in the capillary tube until the latter was completely full, and then the pressure gradually increased, and the diminution of volume read off at intervals of about 10 atmospheres up to about 180 atmospheres.

Curves were then plotted, showing the volume at different pressures for the same temperature, and from these the coefficient of compression at any temperature and pressure was easily deduced.

The following tables are constructed from the curves:—

I. *Mean Coefficients of Compression of Liquid Acetylen at Different Temperatures. Range of Pressure from 36·62 to 182·68 atmospheres.*

Temp. of Acetylen.		Coeff.	Temp. of Acetylen.		Coeff.
35·0° C.	=	0·00085	16·0° C.	=	0·00050
28·6	=	0·00068	4·4	=	0·00038
22·5	=	0·00058	0·0	=	0·00025

II. *Coefficients of Compression at the same Pressure but varying Temperatures.*

Temp. of Acetylen.	Atm. 70.	Atm. 95.	Atm. 120.	Atm. 160.
*49·0° C.	—	0·00343	0·00169	0 00078
*41·0	—	0·00138	0·00099	0·00076
35·0	0·00171	0·00113	0·00078	0·00065
28·6	0·00122	0·00083	0·00072	0·00050
22·5	0·00079	0·00065	0·00057	0·00047
16·0	0·00066	0·00050	0·00049	0·00035
4·4	0·00047	0·00042	0·00034	0·00032
0·0	0·00041	0·00036	0·00025	0·00029

III. *Coefficients of Compression at Varying Pressures and Temperatures Corresponding to the same Volume.*

	Vol. = 97 c.m.m.		Vol. = 92 c.m.m.	
Temp. of Acetylen.	Pressure.	Coeff.	Pressure.	Coeff.
*49·0° C.	170·8 atm.	0·00080		
*41·0	137·0 ,,	0·00085		
35 0	103·2 ,,	0·00093	175·8 atm.	0·00065
28·6	70·0 ,,	0·00120	137·8 ,,	0·00063
22·5	—	—	99·2 ,,	0·00065
16·0	—	—	59·5 ,,	0·00066

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* These two experiments were, of course, made above the critical point.

	Vol. = 101 c.m.m.		Vol. = 89 c.m.m.	
*49·0	126·3 atm.	0·00128		
*41·0	98·3 ,,	0·00132		
35·0	72·7 ,,	0·00167		
22·5	—	—	158·0 atm.	0·00054
16·0	—	—	115·6 ,,	0·00056
4·4	—	—	49·7 ,,	0·00058

It is evident from the above tables that acetylen is governed by the same laws as other compressible liquids; that is to say, its compressibility increases as the temperature rises, but diminishes as the pressure increases. For instance, at a pressure of 95 atmospheres it is three times as compressible at 35° C. as at 0° C.

The volume being the same, the compressibility appears to be nearly the same at different temperatures, which is really due to the curves at high pressures running nearly parallel, thus introducing a corresponding difficulty in the estimation of small differences.

On comparing the compressibility of liquid acetylen with the results obtained by M. Amagat (*Annales de Chem.*, 1877) in the case of benzene, it appears to be about seven times as compressible as the latter body at a temperature of 16° C., and under a pressure of 40 atmospheres. The comparison could not be carried out at higher temperatures, for whereas M. Amagat reaches a temperature of 100° C. with the benzene, I was not able to go beyond 35° C. with the acetylen.

NOTES ON A SAMPLE OF FULLER'S EARTH FOUND IN A FULLONICA RECENTLY EXCAVATED AT POMPEII.*

By WILLIAM THOMSON, F.R.S.E.

In visiting the ancient city of Pompeii in April last, I observed in one of the Fullonica establishments a large square tank set in the ground filled with a white soft substance which was soapy to the touch, and which was pointed out to us as the soap of the ancients. I took a sample of the substance with a view of making a chemical examination of it.

This substance is named by the Italians "Terra Fullonica," and besides being found in the dyers' and washers' quarter of the city, it has been discovered frequently in the ordinary houses which have been excavated.

Among the literature of chemistry I searched for, but failed to find, any mention of this fuller's earth or of its composition, but through the kindness of Sig. Felice Niccoline, Director of the National Museum of Naples, I obtained a pamphlet written by Professor de Luca, entitled "Chemical Researches on 'Terra Fullonica,' found in Pompeii, April 13, 1878."

In this he gives general chemical peculiarities of the clay, such as its being faintly alkaline and containing silica, lime, magnesia, chlorides, and traces of sulphates—potassium and sodium. He gives its composition according to a mechanical analysis as follows:—

50 grms. of the clay stirred in water gave differen residues, which were separated according to their tendency to settle to the bottom.

10·282 grms. settled first, and was composed of sand and carbonate of lime.

17·710 grms. was composed of a little sand and carbonate of lime and much clay.

10·050 grms. is formed of traces of carbonate of lime and much clay; and the fourth residue,

8·230 grms., was greasy to the feel, and plastic, and fused before the blowpipe into a vitreous bead of a yellowish white colour.

Prof. de Luca also states that it contains 17 per cent of water, 24 per cent of matter soluble in hydrochloric acid, and 2·7 per cent carbonic acid, the remainder being insoluble in hydrochloric acid.

On drying the substance thoroughly at 100° C., and then submitting it to analysis, I found it to be composed of—

	Per cent.
Silica	67·145
Alumina	12·857
Oxide of iron	2·107
Lime	6·412
Magnesia	1·822
Carbonic acid	3·451
Manganese	trace
Combined water	3·953
Alkaline salts and loss	2·253
	100·000

PHOSPHORUS IN ANCIENT IRON.

By A. E. ARNOLD, A.I.C.

In former times it has been observed, when iron was made in small forges and at comparatively low temperatures, in a similar manner to that still employed in certain half civilised countries, the greater part of the phosphoric acid passed into the ferriferous slag, and good malleable iron was finally produced tolerably free from phosphorus. The following is an analysis of a scoria produced in Roman or Etruscan times from the specular ore of Elba, which usually contains about 0·04 per cent of phosphoric acid.

Iron protoxide	76·49	per cent
Alumina	2·57	,,
Manganese protoxide.. ..	0·60	,,
Lime	1·32	,,
Magnesia	0·64	,,
Zinc oxide	0·20	,,
Sulphur	0·40	,,
Phosphoric acid	0·34	,,
Silica	14·20	,,
Oxygen and not estimated..	3·88	,,
	100·00	,,

This specimen was taken from a large heap of many thousands of tons of scoria lying on the beach close under the site of Populonia, the Etruscan Pupluna, a town much famed in those times for its iron and copper manufactures. It furnished Scipio with iron in the second Punic war. It is now a deserted site, and but few traces of its former importance remain.

It is of interest to observe in the above analysis that the phosphoric acid is about eight times as much as in the natural ore.

I obtained in February, 1878, a piece of metallic iron from the same district; it originally weighed about 2 kilos., and was somewhat rusted. It was found among scoria in the vicinity of Campiglia, and gave on analysis:—

Combined carbon	0·873	per cent
Graphite	2·853	,,
Silicon..	0·544	,,
Sulphur	0·096	,,
Phosphorus..	0·090	,,
Manganese..	0·091	,,
Iron sesquioxide	2·430	,,
Metallic iron	92·804	,,
Moisture	0·092	,,
	99·873	,,

Of the antiquity of this specimen there is some doubt but it has certainly not been produced in recent times.

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* Read before the British Association for the Advancement of Science (Section B.), Sheffield, 1879.

The high percentage of carbon cannot be adduced as indicative of its modern origin; the researches of Lowthian Bell proving that carbide of iron in contact with iron oxide in the molten state is not necessarily decarburised. Similarly, therefore, the above specimen might have been made contemporaneously with a richly ferruginous scoria, such as the Roman or Etruscan metallurgists produced. The ancients possibly knew iron both cast and wrought, as well as the intermediate steel. Pliny says that iron was made in a similar manner to copper. Making a comparison between puddling and copper smelting, he notes the "remarkable fact that when the ore is fused the metal becomes liquefied like water, *and afterwards acquires a spongy brittle texture*" (xxxiv., 41), which goes to imply that iron first "came to nature" considerably previous to the days of Mr. Cort.

Cast-iron recently produced from Elba ore near the same locality contained three times the quantity of silicon present in the above analysis, the constituents being as follows:—

	I. Per cent.	II. Per cent.	Mean. Per cent.
Carbon	4·306	4·147 (diff.)	4·306
Silicon	1·672	1·676	1·674
Sulphur ..	0·067	0·056	0·067
Phosphorus ..	0·110	0·108	0·109
Manganese ..	0·748	0·757	0·753
Iron	93·256	93·256	93·256
	100·159	100·000	100·165

8, effrey's Square, London,
September 10, 1879.

THE AMMONIACAL COPPER-TEST AND ITS APPLICATION.

By J. STEINER.

My attention having been drawn to the working of the ammoniacal copper test (as recommended by Dr. Pavy) by Mr. Hehner's remarks, I determined to find out whether this process could be applied with advantage to the estimation of sugar in malt liquors, especially when old, black, or "turning" beers are to be analysed. The volumetric determination, as carried out in the usual way with ordinary Fehling's solution, does not give in these instances quite satisfactory results in consequence of the appearance of a deep straw-yellow colour after boiling for some time and when about three-fourths of the total cupric oxide have been reduced. Moreover, the recourse we have to testing a few drops of the filtered and neutralised solution with ferrocyanide fails here because much ammonia is developed from the albuminous matter present, and therefore part of the Cu_2O remains in solution. Just the same is the case when the amount of glucose or "uncrystallisable sugar" in Jaggery, China or Jamaica sugars has to be ascertained, and in other instances, —especially with old pale ale or old lager beer, where the sugar in the beer is reduced by after-fermentation to less than one-half per cent—unless the beer solution be added gradually to the copper test, and the boiling is repeated several times, a muddy hydrated Cu_2O is separated, and remains suspended in the liquor, in which case even filtering is useless, and the test has to be put aside. In carrying out my experiments with an ammoniacal copper solution as prepared by Dr. Pavy or Mr. Hehner, I soon perceived that the different measurements for the two tests impeded the close comparison of the results; and as for the usual sugar test I apply 10+10 c.c. = 20 c.c. of a copper solution, the parts of which I keep in two separate bottles; I repeated the test with the same amount of test-liquor after the addition of about 30 to 40 c.c. of strong ammonia, and with or without 10 c.c. (=1 gr.) of Na_2O. In this manner I arrived at very easily comparable results.

For the ordinary Fehling's test I use a test-tube of about 120 c.c. capacity. It is held direct over a Bunsen flame, and the bumping of the dense liquor is prevented by the addition of a few grains of pumice stone. This very convenient mode of procedure I saw first in Mr. Halse's laboratory, in London. The ammoniacal test I carried out in a boiling flask of about 200 c.c. capacity. It was closed with a perforated cork, and the fumes carried into cold water. It is very essential to prevent an access of air, as the reduced colourless solution very soon becomes blue on lifting the stopper. The beer or the sugar solution was so diluted as to require about 35 to 45 c.c. of the same for 20 c.c. of Fehling. I used, first, inverted pale cane-sugar, and came very soon to the conclusion that 20 c.c. of the copper test corresponded to—

1-10th gr. glucose, in the ordinary mode of testing.
1-12th gr. glucose, with the addition of ammonia + 1 gr. of Na_2O.
1-12·5th gr. glucose, with the addition of ammonia only.

For example:—Required for the ordinary process = 36 c.c. (I.) of sugar solution, but with the addition of ammonia + 1 gr. Na_2O = 30 c.c. (II.), and with ammonia only = 28 8 c.c. (III.).

It will be noticed that these numbers stand to each other in the reversed proportion of 10 : 12 : 12·5; and that 100 c.c. of this sugar solution contain according to—

(I.) 36 : 0·1 = 100 : (x = 0·2778) gr. glucose.
(II.) 30 : 1-12 = 100 : (x = 0·2778) ,, and
(III.) 28·8 : 1-12·5 = 100 : (x = 0·2778) ,,

The same proportion was obtained with inverted brown cane-sugar and with brown starch sugar (English make).

It is worth noticing here that while the ordinary test requires, in presence of dextrin, a rapid working and not a too protracted boiling (or the results become too high), the ammoniacal test, with or without caustic soda, is best carried out gradually with a low flame, to prevent the adhering and decomposition of the test-liquor at the bottom of the flask, and the results are not influenced whether boiling rapidly or only slowly is resorted to. I next used a strong malt wort from the mash in the brewery, diluted 20 c.c. of it to 1000 c.c., and to my surprise, in all the three instances, the same amount of c.c. (=40) was required. I then looked into Mr. Hehner's paper (Chemical News, vol. xxxix., p. 197), and noticed the following statement:—"Dextrose and levulose act equally, but I find that both milk-sugar and maltose possess entirely different reducing power against the two kinds of copper solutions. Thus, a solution of pure milk-sugar acted as follows:—10 c.c. ordinary Fehling required 16·76 c.c., 100 c.c. of Pavy solution = 20·76 c.c. The ratio is therefore quite contrary to that resulting by the action of glucose."

There is, of course, a misconception here, because if it is considered that 100 c.c. of Mr. Hehner's ammoniacal copper solution equal 12 c.c. of ordinary Fehling, and the reduction from 12 to 10 c.c. in the proportion 12 : 10 = 20·76 : x is carried out, we arrive at 17·3 c.c. against 16·76 c.c. in the usual way, with a difference of only 0·24 c.c., and which may be accounted for by the measurement of different quantities used by him. It follows, therefore, from his results that lactose is as little influenced as it is, according to my figures, the case with maltose when ammonia and excess of alkali are added to the common copper solution.

Having established these facts, I now tried a sample of American glucose, which was very white, and judging from the large quantity of the ash and its character, it was manufactured from maize. The result of the two tests, taken together, was that only dextrose was present in this sample; but a glucose of German manufacture, which was also very pale and contained only little ash, gave results which were not concordant. Of 1 gr. dissolved and made up to 250 c.c. were required, with ordinary Fehling's solution, = 36 c.c, and with the addition o

Am+1 gr. Na_2O=32 c.c., and on calculating the reduction as glucose we obtain—

In the one case, $36 : 0{\cdot}1 = 250 : (x = 0{\cdot}6944)$, or 69·44 per cent glucose.

And in the other, $32 : 1{\cdot}12 = 250 : (x = 0{\cdot}6510)$, or 65·10 per cent glucose.

This discord may also be noticed in the following proportion :—$12 : 10 = 36 : (x = 30$ c.c.), instead 32 c.c. as found by analysis, thus proving that there must be another sugar present, which in this instance is of course maltose.

The question now arose, How much maltose and how much glucose or dextrose is present ? and to solve this problem I used the following equations :—

$$\text{I.}\quad g + \tfrac{2}{3}m = F$$
$$\text{II.}\quad 1{\cdot}2\,g + \tfrac{2}{3}m = F'$$

From the combination of which follows—

$$g = \frac{F' - F}{0{\cdot}2}$$

20 c.c. of copper solution are taken here for both tests to be equal to 0·1 gr. of glucose, and as the action of maltose ($=m$) remains the same for both cases, the difference in the obtained results (F and F′) depends on glucose ($=g$), and the amount taken into consideration in the second equation (for the ammoniacal test) is to that (of the ordinary test) in I. too high in the proportion of 1·2 : 1·0.

In applying this conclusion to the values given above, we have—

$$36 : 0{\cdot}1 = 250 : (x = 0{\cdot}6944) \text{ gr. and}$$
$$32 : 0{\cdot}1 = 250 : (x = 0{\cdot}7812) \text{ ,,}$$

Therefore—

$$g = \frac{0{\cdot}7812 - 0{\cdot}6944}{0{\cdot}2} = 0{\cdot}434 \text{ gr., or } 43{\cdot}4 \text{ p.c. glucose.}$$

From the equation—

$$m = \frac{3(F - g)}{2}$$

follows now—

$$m = \frac{3(0{\cdot}6944 - 0{\cdot}434)}{2} = 0{\cdot}3906 \text{ gr., or } 39{\cdot}1 \text{ p.c. maltose.}$$

The sample under examination contains, therefore, a total of 82·5 per cent fermentable sugars.

On inverting a solution of 1 gr. of this sample for six hours under pressure in a salt-bath I obtained, after diluting to 250 c.c., the following results with the two tests :—

I. 30 c.c. : $0{\cdot}1 = 250 : (x = 0{\cdot}8333)$, or 83·33 p.c. glucose.
II. 24·8 c.c. : $\frac{1}{12} = 250 : (x = 0{\cdot}8400)$, or 84·0 ,, ,,

Hence there was no dextrin present, and the sample consisted solely of glucose and maltose.

There is another mode of calculation, viz. :—

Let x be the number of c.c. of maltose and y be the number of c.c. of glucose which participate in reducing 20 c.c. of Fehling.

Then is $x + y = a$ c.c. for the common test,

And $x + \frac{10}{12}y = b$ c.c. for the ammoniacal and alkaline test,

Consequently $y = 6(a - b)$.

On applying this formula to the case considered above, we find $y = 6(36 - 32) = 24$ c.c., and as the total volume required in the ordinary test is 36 c.c., we learn from the proportion 36 c.c. : 24 = 0·1 gr. : (x = 0·0667) that out of the matter which reduces Fehling here 66·7 per cent is real glucose, and therefore the total amount of dextrose may be calculated from the following proportion :—

$100 : 66{\cdot}7 = 0{\cdot}6944 : (x = 0{\cdot}4631)$ gr., or 46·31 per cent.

For the maltose remains, therefore, $\tfrac{3}{2}(0{\cdot}6944 - 0{\cdot}4631) = 0{\cdot}347$ gr., or 34·7 per cent.

The two calculations did, therefore, not lead to the same result, and in order to obtain a better insight into this subject I mixed solutions of inverted cane-sugar with diluted fresh malt-worts, and analysed several of these liquors before and after mixing them. The conclusion I arrived at now was that the fault lies, first, in the measurement, *i.e.*, the burettes used for such work should permit an accurate reading off of $\frac{1}{100}$ c.c. ; and, secondly, that the working of the ordinary Fehling's test requires to be most carefully watched, and repeated before the result may be noted down. In the subjoined data I give the details of such an experiment.

	With Fehling.	With Am. Copper Solution.
Dilute wort required	35·6 c.c. and	35·6 cc.
Inverted cane-sugar required..	46·3 ,,	38·6 ,,
50 c.c. of wort mixed with 50 c.c. sugar solution	40·9 ,,	37·2 ,,

I. If we substitute the respective numbers in $y = 6(a - b)$ we obtain $y = 6(40{\cdot}9 - 37{\cdot}2) = 22{\cdot}2$ c.c. for glucose, while the real amount is—

$$\frac{46{\cdot}3}{2} = 23{\cdot}15 \text{ c.c.}$$

II. 100 c.c. of the mixture contain, if expressed as glucose—

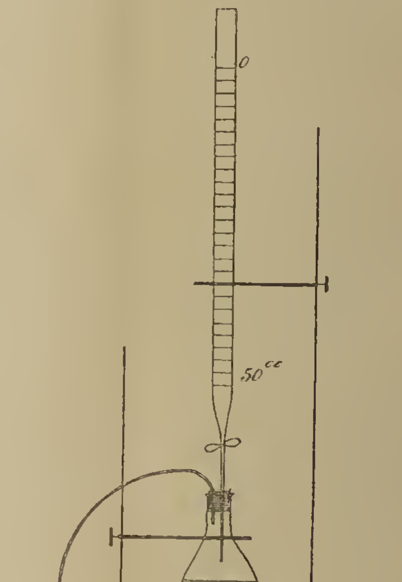
$40{\cdot}9 : 0{\cdot}1 = 100 : (x = 0{\cdot}2445)$ gr. according to the usual copper test,

And $37{\cdot}2 : 0{\cdot}1 = 100 : (x = 0{\cdot}2688)$ gr. according to the ammoniacal test.

Therefore—

$$g = \frac{0{\cdot}2688 - 0{\cdot}2445}{0{\cdot}2} = 0{\cdot}1215 \text{ gr.}$$

instead of 0·1080 gr. as the following proportion shows :—$46{\cdot}3 : 0{\cdot}1 = 50 : (x = 0{\cdot}108$ gr.).



The results obtained for such cases are therefore only approximate, and we have still to resort to the application of the polariscope, which, considering the large amount of substance used for a "normal solution," offers much more reliable data for calculation, and its indications ought never to be neglected in the analysis of starch-sugar. Nevertheless, I consider the ammoniacal alkaline copper test as most valuable for telling by merely analytical means whether a starch-sugar or a beer contains only one sugar or if two of them are present ; and, as pointed out in the introduction of this paper, such analysis is very reliable if there be only one sugar, like in diabetic urine, or as in most beers and in raw sugars. In conclusion I will offer a few hints as to the *modus operandi*.

The apparatus used for this test is shown in the annexed sketch. The boiling flask should not be filled to more than two-thirds of its capacity. It is best first to ascertain with the usual test how many c.c. of the sugar solution are required, then to calculate from this according to the proportion 12 : 10 how much will be necessary for the reduction of the ammoniacal solution in the flask, and now to add at once before boiling the total amount less about 1 c.c. as a too protracted boiling drives out so much of the ammonia that Cu_2O is deposited and the test has to be repeated. The flame must be constantly in the operator's hand, and should not touch the bottom of the flask when the reduction once sets in, to prevent a burning and decomposition. The sugar solution must not be poured in while the flame is applied, or even while there are yet bubbles on the surface of the hot liquor in the flask, or the ammonia will pass up into the burette, alter the meniscus, and partly decompose the solution in it. The test is finished when a slight yellow tinge appears on looking on the surface of the hot liquor: a white cardboard as background aids the observation materially. The india-rubber tube is closed at the end, and a Bunsen valve, *i e.*, a longitudinal slit in it near the end, permits the gas to escape, and prevents the entrance of the cold water. This test has only one, but for many reasons a very objectionable, drawback, viz., the unavoidable penetrating smell of the ammonia. A water analyst, for example, could never make use of it in the same locality where the amount of ammonia in drinking-water has to be ascertained; or some of the analysts in the City will have to avoid it for fear of creating a public nuisance.

ON THE DISSOCIATION OF CHLORINE.

By F. P. DUNNINGTON, University of Virginia.

In view of the following facts, the question suggests itself whether due care has been taken to exclude the possibility of oxygen compounds being present in the experiments, from which the decomposition of chlorine was inferred, in the article published in the Chemical News, vol. xl., p. 69.

During the past year in undertaking to make liquid Cl from $PtCl_4$ made by HNO_3 and HCl (the latter in excess) I experienced some difficulty in obtaining it free of nitro compounds.

After heating about 30 grms. $PtCl_4$ until Cl was given off, thrice it was treated with water, causing the evolution of nitrous fumes, and heated again until Cl was given off. This material sealed in a glass tube, on being further heated gave Cl, which condensed at first to a clear yellow liquid (exactly similar in colour to that of liquid Cl made from $Cl,5H_2O$), but on continuing the heat the condensed liquid assumed a red-brown tint. From the fact of the nitrous fumes having been evolved when it was last treated with water, I presume the reddish tint of this liquid due to NOCl or $NOCl_2$. On opening the tube, when most of the Cl had escaped, there remained an odour very similar to that of ClO_2.

In a previous experiment when the $PtCl_4$ was but once moistened after drying, the condensed liquid Cl had from the first this same tint, though to a more marked degree. In another experiment I did obtain the Cl from $PtCl_4$ wholly of the clear yellow colour.

In these experiments the residue after heating consisted of $PtCl_2$, with but little Pt and $PtCl_4$.

Detection of Phenol.—Dr. E. Hoffmann pours into a small test-glass 1 or 2 c.c. of pure concentrated sulphuric acid, pours carefully over it, so as to form a separate layer, the same volume of the dilute aqueous liquid suspected, and drops in a few granules of potassium nitrate. If only 1 milligrm. of phenol be present each particle produces at once violet streaks.—*Chemiker Zeitung.*

IRRIGATIONISM IN FRANCE.

It appears that certain engineers are making the attempt —if they have not already succeeded—to dispose of the sewage of Paris by converting the forest of St. Germain into an irrigation field. The question has been discussed before the Société d'Hygiène, and the debate is now continued in the *Journal d'Hygiène*, where M. Tollet and M. Duverdy have come forward in defence of the forest. They point out that it would be very unfortunate both for the salubrity and the amenity of the environs of Paris should this forest be cut down and rooted up. Although the Engineers of the city of Paris ask for one-third only of the forest, yet, as M. Duverdy very justly remarks, if once allowed to set foot in the forest they will speedily declare that one-third of the region does not suffice for the absorption of their sewage, and the remaining two-thirds will be in danger of the same fate.

M. Marié-Davy seems to believe that the trees might still be preserved even though the ground should be irrigated, and would even flourish more luxuriantly. This, however, is a capital error. The surface of the soil in a forest is not regularly turned over with the spade or the plough, and consequently, if drenched with sewage day by day, it will become felted up with the fibrous matters held in suspension, and be rendered impermeable. Very few forest trees can support a perpetual irrigation which must be applied all the year round, even during the season when the sap does not circulate. M. Marié-Davy, borrowing the expression of M. Durand-Claye, terms the part of the forest more immediately coveted by the engineers "an arid desert." M. Duverdy, on the contrary, shows that the trees, where not injured by rabbits, are healthy and luxuriant, and that the forest is valued by competent judges at 4200 francs the hectare,—a price which fully refutes the charges of aridity and barrenness.

In these days the sanitary value of trees in and near great cities is recognised by the highest authorities, and we trust the powers that be will not sanction an act of such wanton Vandalism. A palace burnt down may be re-erected, but a forest laid waste is almost irreparable.

NOTICES OF BOOKS.

Spon's Encyclopædia of the Industrial Arts, Manufactures, and Commercial Products. Edited by G. G. André, F.G.S. Division I. London: E. and F. N. Spon.

The exact scope of this important work is not very easy to define. From the contents of this first division it might be taken for a dictionary of technological chemistry. The prospectus, however, promises to deal with many subjects not included among the chemical arts, such as hat, fan, and glove making, the manufacture of cotton, linen, silks, and woollens, &c. On the other hand, there is no mention of several important topics which could not well be overlooked in a work purporting to be a general encyclopædia of the useful arts. It seems to be the plan of the editor to discard what may be called the dictionary arrangement, and to group the information given under comparatively few heads, each of which will have to be carefully searched through by those in quest of any particular fact. The difficulty is enhanced by the circumstance that within these primary divisions the alphabetical arrangement is not always observed. Thus, in the chapter on acids we find the following compounds only described, and in the succession given: Acetic, arsenious, carbazotic (picric), carbolic, carbonic, chromic, citric, gallic, sulphuric, hydrochloric, hydrofluoric, nitric, oxalic, and tartaric. It will at once strike the reader not merely that many important acids are omitted, but that the sulphuric acid is curiously out of place.

The salts are also distributed, some being placed under their respective acids, whilst others are appended to their basic constituents, *e.g.*, under the head "Alkalies." Hence we think that, especially as cross-references are not very abundant, a good index will be found absolutely necessary, and till it appears the value of the work cannot be fully appreciated.

As for the subject-matter of this encyclopædia we are happy to pronounce it very much superior to the arrangement, which, however, renders the latter more to be regretted. Many of the descriptions of manufacturing processes are accurately and carefully compiled, and are accompanied with abundance of illustrations. Still we cannot, in every case, agree with the writers. Thus, in the account of oxalic acid a process is described at very considerable length for its manufacture from guano, *i.e.*, from uric acid. We always regarded this invention as one of the curiosities of patent literature, unmatched save, perhaps, by a certain process for using alum as a source for potash and ammonia (Specification No. 938, A.D. 1855). In civilised countries uric acid is likely to be at all times much more costly than oxalic acid, and in guano islands the latter acid, if needed, can surely be imported to better advantage than prepared in this manner. The process, indeed, sins against that golden rule, "never use a nitrogenous substance as the raw material for a non-nitrogenous compound."

Prof. Wanklyn's process for the analysis of waters,—which is introduced under the head, not of water, but of ammonia—is imperfectly described. The operator is directed first to distil the water *alone*, when the distillate will contain the free ammonia, and then to add the alkaline permanganate and distil again for the determination of the nitrogen present in organic combination, or so-called albuminoid ammonia. A reference to Prof. Wanklyn's book on water analysis would have shown the writer that in order to find the nitrogen present in water in the form of ammoniacal salts it is necessary to distil the sample along with carbonate of soda. The writer afterwards mentions a solution of sodic carbonate, as "required for the application of the Nessler test," but he omits to say how and when such solution is to be used. The solution of chromic acid in water is described as being of a dark-brown colour. We have always found it of a scarlet.

Under the article "Beverages" we read: "Beer and porter are manufactured in enormous quantities in England, comparatively little being made anywhere else." Under "Alcohol," again, we find it stated that "the manufacture of ale and porter is confined to our own country." From these two passages the conclusion might be drawn that the production of malt-liquors was scarcely known abroad—an utterance at which Bavaria and Belgium would feel greatly astonished. At the foot of p. 193 we are told "it is reasonable to expect that a still further impetus will be given to the production of wines and spirits in England." On turning over the leaf we find that the author has also "turned over a new leaf," since he writes: "Wines . . . are not produced in any quantity in the British Isles."

In treating of hydrochloric acid, and generally of the noxious fumes arising from manufacturing operations, the authors quote some interesting statistical results obtained and published by the Belgian Government, showing that in four districts the total average death-rate had actually fallen since the introduction of chemical works. In one of the districts, however, there was an increase. We must beware, therefore, of laying too much weight upon these figures, especially as an apparently plausible attempt has been made to show that the health of a certain neighbourhood had been improved by the installation of a sewage-irrigation farm.

We shall watch the further progress of this work with much interest, trusting that as it proceeds its defects will be eliminated, and its many good features be rendered more prominent.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 6, August 11, 1879.

Experimental Researches on the Erosive Action of Gases, strongly Compressed and Heated, with Reference to the History of Meteorites.—M. Daubrée.—In this memoir the author shows that the erosive force of gases increases very rapidly with their pressure and temperature. To the purely mechanical phenomena there are always superadded calorific effects, and often chemical reactions. All these actions acquire a surprising energy when the gases, instead of whirling round in a space closed on all sides, are projected in a determined direction; for instance, when they escape by a narrow aperture.

Acids formed on the Distillation of the Crude Acids obtained by the Saponification of Neutral Fatty Bodies in a Current of Superheated Steam.—MM. A. Cahours and E. Demarçay.—The acids formed under these circumstances are the valerianic, the caproic, œnanthylic, and caprylic.

Reply to the Remarks of M. Berthelot on the Author's Note concerning Chloral Hydrate.—A. Würtz.—The author defends his method of experimentation against the strictures of M. Berthelot.

Production of Electricity by the Rays.—C. Robin.—The author confirms by fresh experiments his former demonstration (A.D. 1865), that the electric organ in the tail of the Ray acts like those of the Torpedo and the Gymnotus, the differences being merely of a secondary nature.

Distillation of Liquids under the Influence of Static Electricity.—D. Gernez.—The distillation observed is almost exclusively a transportation of the liquid effected by means of electricity along the moistened (and therefore conductive) sides of the apparatus. The author finds, however, no relation between the quantities of the liquids thus conveyed, other things being equal, and the capillary constants of these liquids. There is a certain agreement between the manner in which the phenomena varies and the conductibility of the liquids. Doubtless if the liquid is a very bad conductor, like carbon, chloride, and sulphide, no distillation takes place, but if the charge passes at all the transferrence is the more abundant the lower is the conductive power of the liquid. If we submit to the action of the discharge a homogeneous mixture of two liquids, the action of the electricity determines a partial separation of the two liquids, which distil in proportions having no relation either with the volatility or the conductibility of the substance.

The Currents of Ampère, and on Residual Magnetism.—M. Tréve.—A shock upon an electro-magnet, whether solid or tubular, at the moment when the current ceases, is sufficient to diminish the duration of its demagnetisation to a considerable extent, and is consequently a remedy for remanent magnetism.

Vapour-Densities of Certain Organic Bodies Boiling at High Temperatures.—L. Troost.—The observed vapour-density of anhydrous phthalic acid is 5·23 (by calculation 5·13), and its volume equivalent is 4. Resorcin has the vapour-density 3·807 observed, 3·81 calculated. Ethyl-benzoic ether, 5·55 observed, and 5·2 calculated. Amyl-benzoic ether, 6·69 observed, and 6·65 calculated. The volume equivalent is in each case 4.

Density of Chlorine at High Temperatures.—A. Lieben.—The author comments on the fact observed by V. and C. Meyer that at temperatures exceeding 600° the sp. gr. of chlorine is only 1·63 instead of 2·45 (air = 1). He seeks to explain this fact by the supposition that above 700° chlorine follows a law of expansion different from other gases, its coefficient of expansion being possibly somewhat higher than those of oxygen, nitrogen, gaseous sulphur, &c. He suggests as another explanation that at high temperatures the molecules of chlorine, Cl_2, are dissociated into isolated atoms.

Synthesis of Phenol-glucoside and of Ortho-formyl-glucoside or Helicin.—A. Michael.—The reaction of aceto-chlor-hydrose with potassium salicylite gives rise to helicin.

Compound of Chromic Acid with Potassium Fluoride.—L. Varenne.—The author assigns to this compound the formula $KFl,2CrO_3$. It is resolved by alkalies into potassium fluoride and an alkaline chromate.

Production of Crystalline Magnetic Oxides by means of Potassium Cyanide.—L. Varenne.—A stannous salt treated with potassium cyanide precipitates stannous oxide, which, after being boiled with the cyanide for two or three days, is transformed into a crystalline oxide.

Identity of Hydrate of Di-isopren and Caoutchin with Terpen.—G. Bouchardat.—The nature of this paper appears sufficiently from its title.

No. 7, August 18, 1879.

Observations on the Reply of M. Würtz relative to Chloral Hydrate.—M. Berthelot.—Our learned colleague has not effected the justification, indispensable in every physical inquiry, of the limits of his experimental errors. The observation which he adduces relative to the rise of temperature produced in his apparatus by the union of nitrogen binoxide and oxygen cannot supply it, but may rather be invoked to show the whole extent of the causes of error inherent in his method.

Scintillation of the Flames of Gas Lamps.—F. A. Forel.—The author has observed that the flame of gas lamps when viewed from a considerable distance scintillates like the stars, and considers that the laws of this phenomenon may be thus conveniently studied, as all the conditions of the atmospheric stratum between the source of light and the observer, such as the pressure, moisture, temperature, &c., may be much more readily ascertained than similar conditions in the upper regions of the air.

Absorption of Nitric Oxide by Ferrous Salts.—J. Gay.—Ferrous salts absorb nitric oxide in variable proportions according to the temperature and the elastic force of the atmosphere of binoxide remaining in contact with the salt. Up to 8°, and under the atmospheric pressure, the quantity of nitric oxide absorbed by ferrous salts corresponds to $10NO_2$ for 1 equiv. = 28 of iron. Hence, the formula of the compound is $3(FeSO_4)+NO_2$. Above that temperature and up to about 25° and under a pressure of about 760 m.m. the quantity of nitrous oxide absorbed is less, and corresponds to Peligot's formula, $4(FeSO_4)+NO_2$. Above 25° the formula of the saturated solutions agrees with $5(FeSO_4)+NO_2$. The author has succeeded in expelling all the nitric oxide and recovering the ferrous salt unchanged by passing through it a current of hydrogen, air being excluded. Reducing agents decompose the nitric oxide contained in ferrous salts, and liberate a mixture of nitrogen and nitrous oxide.

Reaction of Zinc Chloride upon Normal Butylic Alcohol.—MM. Le Bel and Greene.—The butylene of erythrite, our normal dimethyl-ethylen, is the final term of the reactions of zinc chloride upon the butylic alcohols.

Determination of Urea in Urines.—G. Esbach.—The author criticises the results furnished by M. Méhu on July 21. It is correct that a solution of glucose and of urea yields more gas than if the urea were alone, but the excess instead of being proportionate to the quantity of urea varies according to the glucose added.

Thermic Studies upon Nitro-glycerin.—H. Boutmy.—A thermic comparison between the direct process of manufacturing nitro-glycerin and that of Vonges, which turns on the mutual reaction of the sulpho-glyceric and sulpho-nitric acids.

Elimination of Bromine from Bromo-citraconic Acid and on a New Organic Acid.—E. Bourgoin.—The author has eliminated the whole of the bromine from bromo-citraconic acid by means of silver oxide, a new acid being formed. This acid differs from the pyromucic by containing 2 equivs. of hydrogen more, and from citraconic by containing 2 equivs. of hydrogen less.

On Scandium.—P. Clève.

Oxygen Acids of Sulphur.—M. Maumené.—The action of iodine and barium hyposulphite, which yielded to Fordos and Gelis the tetrathionates, can yield according to the author's theory seven other acids. Two of these which precede S_4O_5, the author has already obtained, namely S_2O_3 and S_6O_8. The second of these is easily formed on mixing 3 equivs. of the hyposulphite with 2 of iodine.

Composition of Slate.—M. Maumené.—The author points out that certain kinds of this rock contain as much as 0·5 per cent of calcium carbonate, and are consequently readily attacked by atmospheric agents.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.

No. 63, March, 1879.

Report by M. le Compte du Moncel on M. Gaiffe's Peroxide of Manganese and Zinc Chloride Battery. The advantages of the Leclanché battery (manganic peroxide and sal-ammoniac) are well known, as it will act for entire years without attention. Hence it is almost universally applied for electric purposes where no great power is needed. If the manganic peroxide, however, is once exhausted they are rendered unserviceable, and must be replaced by new ones. M. Gaiffe, by his new arrangements, has overcome this difficulty, so that the elements may be charged as easily as in other batteries. He places the peroxide of manganese in several deep holes excavated in the cylinder of carbon, which forms the negative electrode and which serves at the same time as a porous vessel. This carbon is steeped in a solution of zinc chloride, which serves as the exciting liquid, and a rod of amalgamated zinc forms the negative pole. The chloride of zinc should contain from 15 to 20 of the salt of zinc, as neutral as possible and free from lead. The manganese should be in granules. The electromotive force of this element is equal to a couple and a half of Daniell.

Gazzetta Chimica Italiana.

Anno ix., 1879. Fasc. 1.

Various Observations on Digallic Acid.—Prof. Ugo Schiff.—A lengthy paper not susceptible of useful abstraction.

Reaction of Salicylic Acid with Salts of Iron.—Stefano Pagliani.—Robinet proposed a method for the detection of salicylic acid in wines and urine, which consists in treating the liquids with acetate of lead, filtering, adding to the filtrate an excess of sulphuric acid, and applying to the clear solution a few drops of ferric chloride, when a violet colouration shows the presence of salicylic acid. Marty and Dollfus call this process in question, affirming that the reaction is not produced in neutral ferric solutions, and is hindered by free acids, even the acetic. The author finds that the excess necessary to destroy the reaction by a known quantity of water containing sulphuric acid is when its weight is 400 times greater than that of the salicylic acid present. If nitric acid be used in place of sulphuric the excess must not go beyond 385, and in case of hydrochloric acid the proportion must not be 36 times greater than that of the salicylic acid.

Action of Sulphuric Anhydride upon Pseudo-sulpho-cyanate of Phenyl.—G. Magatti.—The author obtained by this reaction a yellowish crystalline body of the composition $C_7H_5NS_2O_3$. On treatment with boiling water it is resolved into hydrosulphuric, carbonic, and sulphanilic acids.

Preparation of Naphthylic Urea.—S. Pagliani.—The author has prepared and examined dinaphthyl urea.

Poisonous and Crystalline Ptomain extracted by means of Ether from two exhumed Bodies in which Arsenic had been Detected in Quantity.—F. Selmi.—The author describes the reaction of this compound, and which appear to be those of an alkaloid. It produced strongly-marked symptoms of poisoning in a frog, though the absence of arsenic and phosphorus had been previously ascertained.

Genesis of Poisonous Alkaloids in Corpses.—F. Selmi.—These compounds seem to be formed on the slow decomposition of albuminoids in the absence of oxygen.

Phenomena observed in the Plastering of Wines and Musts.—Prof. E. Pollacci.—The sulphate of potassa produced on plastering is an acid, not a neutral salt. If gypsum is added during fermentation the proportion of alkaline sulphate in the wine may reach 5 or 6 grms. per litre. Calcium tartrates and sulphates are further present in such quantity that the wines may be regarded as saturated solutions of these salts. In the fermentation of plastered grapes sulphuretted hydrogen is evolved, and ethylic mercaptan is formed, sometimes in quantity perceptible both by smell and and taste.

Anno ix., 1879. Fasc. 2.

New Researches on Picrotoxin.—E. Paterno and A. Oglialoro.—The authors have discovered a new method for preparing picrotoxic hydrate in quantity. They heat an alcoholic solution of picrotoxin to ebullition, saturate with dry gaseous hydrochloric acid, distil off the bulk of the alcohol, mix the residue with water, and agitate the aqueous solution repeatedly with ether. The ethereal solution on evaporation leaves an abundant residue of picrotoxin hydrate. They have also obtained certain substitution products, such as a mono-benzoilic and a bi-acetilic.

Supposed Identity of Columbin and Limonin.—E. Paterno and A. Oglialoro.—These products differ in composition, in boiling-point, and in other characters.

Researches on Cinchonin.—M. Fileti.—An examination of the chlorine and bromine substitution derivatives of this base.

Analysis of the Spinell of Tiriolo in Calabria.—Dr. F. Mauro.—This mineral is a triple aluminate of zinc, manganese, and iron, along with a trace of antimonious acid.

Analysis of the Thermal Waters of Termini-Imerese.—E. Paterno and G. Mazzara.—Of no general interest.

Disulph-ethylidenic Acid.—Prof. J. Guareschi.—A description of this acid and of a number of its salts.

Gum of the Coloured Quebracho (*Loxopterigium Lorentii*).—Prof. N. Arata.—This exudation is of a red colour; it is soluble in boiling water, which, on cooling, deposits a part only; insoluble in benzol, carbon disulphide, chloroform, and essence of turpentine; but it dissolves readily in alcohol, aceton, and acetic ether. It is sparingly soluble in amylic alcohol and acetic acid. Hence it can neither be regarded as a gum nor as a true resin. It has no analogy with catechu or gambir, but approaches rather to kino.

Chemiker Zeitung.

No. 14, April 3, 1879.

Application of Watery Vapour in the Distillation of Liquids.—L. Ramdohr.—It is found that in the distillation of the liquid and solid hydrocarbons from lignite-tar, petroleum, rosin, rosin oils, &c., the introduction of superheated steam is very useful to prevent undesirable decompositions. The author has contrived an apparatus by which the steam is superheated inside the still, its temperature agreeing with the boiling-point of the contents.

Poisonous Colours.—According to the *Apotheker Zeitung*, of 118 samples of children's toys officially examined in 1878, 53, or nearly one half, were found adorned with poisonous colours. In 46 of these cases the vendors were punished.

Tannin in Algarobillo.—According to R. Godeffroy (in the *Zeitschrift d. Oest. Apoth. Vereins*) the pods of *Balsamocarpum crevifolium*, or algarobillo, contain 68·38 per cent of tannin, and are an excellent material for the manufacture of this substance.

Die Chemische Industrie.

No. 7, July, 1879.

Injury to Vegetation by Acid Gases.—R. Hasenclever.—The author admits that many causes in addition to the fumes of chemical works have had a deleterious action upon trees. He points out that the use of coal as fuel, whether in private houses, in mechanical manufactures, &c., has exerted a very devastating action upon vegetation. [The inference is, therefore, plain that restrictions upon the chemical arts to whatever length they might be carried must fail to prevent the injuries of which farmers and land-owners complain.] The memoir is accompanied by a coloured engraving of the leaves of various trees as affected by acid vapours. German observations confirm the view entertained in this country that the plane-tree is distinguished by its power of resisting acids.

Atti della R. Accademia dei Lincei.

Fascicolo 2, 1879.

Chemical Analysis of the Spinell of Tiriolo in Calabria.—Dr. F. Mauro.—Already noticed.

Disulphethylidenic Acid.—Prof. Guareschi.—Already noticed.

Secure and Delicate Process for the Toxicological Detection of Arsenic.—Prof. Selmi.—The method is that of Schneider modified so as to incur no losses. The substance to be examined is treated with hot concentrated sulphuric acid, and during the same time is traversed by a current of hydrochloric acid gas, which carries with it all the arsenic in the state of chloride, separating it from the organic substances with which it was mixed. The arsenical liquid is then placed in a Marsh's apparatus and tested in the usual manner. The author has been thus able to obtain the metallic ring on operating upon 100 grms. of animal matter containing 1-400th of a milligrm. of arsenious anhydride. The author criticises the process of Gautier, which answers for recent matter, but should not be adopted if the subject is putrid or mummified.

Fascicolo 3, 1879.

This part contains no chemical papers.

Reimann's Färber Zeitung,

No. 30, 1879.

Remarks on Pittical.—If pittical is separated from its alkaline salts, and heated with alcoholic ammonia in a sealed tube to 176°, a base is obtained closely resembling rosanilin in its composition. It is a triamin, and dissolves in acetic acid with a corn-flower blue colour. The new colour is the first member of a new series of tinctorial products, which may prove of great importance.

COMPOSITION AND QUALITY OF THE METROPOLITAN WATER.

August, 1879.

The following are the returns of the Society of Medical Officers of Health:—

	Appearance in 2 foot Tube.	Ammonia.		Nitrogen as Nitrates, &c.	Oxygen used to Oxidise Organic Matter.	Total Solids.	Lime.	Magnesia	Chlorine	Sulphuric Anhydride.	Hardness on Clark's Scale	
		Saline. Grs.	Organic. Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Before Boiling. Degrees	After Boiling. Degrees
Thames Water Companies.												
Grand Junction	Clear	0·000	0·011	0·120	0·120	20·20	7·750	0·518	1·008	1·367	15·2	5·0
West Middlesex	Clear	0·000	0·011	0·120	0·149	20·90	8·060	0·468	1·008	1·267	15·7	4·8
Southwark and Vauxhall	Clear	0·000	0·006	0·105	0·109	20·50	8·090	0·432	1·008	1·266	15·7	4·8
Chelsea	Clear	0·000	0·010	0·090	0·101	20·00	8·010	0·396	1·080	1·330	14·7	5·4
Lambeth	Clear	0·000	0·010	0·135	0·123	20·60	8·620	0·812	1·080	1·500	16·3	5·3
Other Companies.												
Kent	Clear	0·000	0·002	0·420	0·028	29·00	8 170	0·696	1·800	1·400	19·8	5·8
New River	Clear	0·000	0·004	0·120	0·107	20·20	8·170	0·460	1·008	1·430	15·4	5·0
East London	Clear	0·000	0·008	0·111	0·073	20·70	7·630	0·648	1·008	1·400	15·2	5·8

The quantities of the several constituents are stated in grains per imperial gallon.

Note.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

C. Meymott Tidy, M.B.

TO CORRESPONDENTS.

We cordially thank those gentlemen who kindly supplied us with the requisite information relative to the various Examining Bodies, Colleges, and Schools of Chemistry given in our Students' number.

Erratum.—On page 125, line 4 from top, *for* Queenwood College, near Stockbridge, Hants, Mr. E. W. Prevost, Ph.D., *read* Queenwood College, near Stockbridge, Hants, Mr. H. Wilson Hake, Ph.D. The instruction at this college commences, we are informed, on the 25th inst.

J. Parry.—You will find an explanation in any text-book of Physics.

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THE CHEMICAL NEWS.

Vol. XL. No. 1035.

ON THE SPECTRUM OF THE EARTHS FORMING PART OF THE YTTRIA GROUP.

By M. J. L. SORET.

M. Clève communicated to the Academy at their Meeting on Sept. 1, a note on two new elements in erbia (see Chemical News, vol. xl., p. 125). I crave permission to offer the following remarks on that note.

(1.) M. Clève characterises one of those two elements, for which he proposes the name of holmium, by two absorption rays, one in the red, $\lambda=640$, the other in the yellow-green, $\lambda=536$. It doubtless escaped his memory that more than a year ago[*] I pointed out those two rays as not belonging to erbia, but to a new earth, whose probable existence had been announced by MM. Delafontaine and Marignac, and which, for the time being, I designated X. Since then M. Delafontaine has given the name of *philippia* to a substance he has pointed out as identical with X. The description which he has at present given[†] is not sufficiently complete to enable me to deny or affirm this identity, but I am inclined to admit it, taking into account, however, some reservations made by M. Delafontaine on the purity of his product.

I would remind you also that besides the two above-mentioned rays, I recognised in the visible spectrum of the earth X (solar light) three other rays or absorption-bands, the one less refrangible than A, the second overlapping the ray of erbia, $\lambda=450$, in the indigo;[‡] the third (faint) in the violet, a little beyond *h*. Finally, I described the ultra-violet spectrum of this earth, which is still more characteristic, and shows six maxima of absorption from H to R.

Since that time these results have been confirmed by the examination of a great number of products placed at my disposal by M. Marignac. I have constantly found that these different rays increase or diminish in intensity simultaneously, whilst the erbia rays behave quite differently.

In samarskite this earth X is, relatively to erbia, much more abundant than in gadolinite. Thus, in the majority of the products of samarskite, the ray $\lambda=536$ is darker than the ray α of erbia, $\lambda=523$. It is habitually the reverse in the gadolinite products.

I do not think that the difference between the rays of erbia and those of the earth X can be explained by actions analogous to those observed by Prof. Lawrence Smith and M. Lecoq de Boisbaudran in their researches on the spectra of didymium and erbium nitrates, when an excess of acid was added.[§] I have, however, found the same general characteristics in the chlorides and nitrates with excess of acid.

Upon the whole I think the existence of the earth X is fully demonstrated, but I see in M. Clève's note no result proving holmium to be a different body.

(2.) M. Clève characterises by a red ray $\lambda=684$, his second new element, which he proposes to call *Thulium*. I have already directed attention to the fact that in the products rich in earth X, and at a feeble equivalent this ray 684 is not to be met with, whilst all the other rays of erbia can easily be distinguished.[*] I added in a note that the variations of this ray were perhaps in correlation with some new facts observed by M. Marignac, who, indeed, was then occupied in the preparation of ytterbia, and had given me some products to examine with the spectroscope, in which products the latter earth was already strongly concentrated. In these products the ray 684 had taken a predominant intensity, whilst those of erbia, and especially those of the earth X, were weakened. But when the ytterbia had been still further purified, the intensity of the ray 684 diminished also, and in the last product it existed only as a trace, as M. Marignac has stated in his paper.[†] The following results were, for example, obtained on the four principal rays of the red, which formerly were attributed to erbia.

Rays visible in the Order of their Intensity.

Ytterbia, almost pure ..	Equivalent 131: only a trace of ray 168 is to be seen.
Mixture	Equivalent 128 : 684 (well-marked; 653 (faint); 667 (640 no trace).
Mixture	Equivalent 124 : 653 (well marked), 684, 667, 640.
Mixture	Equivalent 120: 653, 684; then 667 and 640 perceptibly equal.

If, then, neither I nor M. Marignac, who would have been far more authorised in doing so, have drawn no positive conclusion from these facts, it is because it seemed to us that in a question so difficult it is perhaps premature to affirm the existence of a new element whilst it is still impossible to isolate it or to determine its chemical characteristics, the only ground for the supposition being the presence of a single ray in the absorption spectrum. —*Comptes Rendus*, September 15, 1879.

RESEARCHES ON ERBIA.

By M. LECOQ DE BOISBAUDRAN.

In the *Comptes Rendus* for September 1st M. Clève announces that he has divided erbia into several distinct earths, which he proposes to name *Erbia*, *Oxide of Thulium*, and *Oxide of Holmium*. The absorption spectrum attributed originally to erbia alone would thus be the result of the superposition of the spectra of three earths.

It is to be remarked that the holmium rays are precisely those pointed out by M. Soret as most characteristic of his earth, X. The two substances are evidently identical.

I am ignorant of the extent to which M. Soret has carried his examination of the red ray attributed by M. Clève to thulium, but he had specially pointed out to me its existence (to the almost entire exclusion of the other red rays of erbia) in a sample of impure ytterbia which he sent me a few months ago. This ray always seemed to me much less narrow than that of ordinary erbia, and appeared to form rather a broad band.

After a visit paid by M. Soret to M. Wurtz's laboratory, where I was working last spring, I undertook some experiments on the question of the plurality of erbia earths. Detained as I am at Cognac, and consequently prevented from immediately completing the examination of my products, left behind in Paris, I must beg the Academy to receive the following statement of my observations, incomplete as they still are.

On M. Soret's announcement of the probable existence

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[*] See *Comptes Rendus*, April 29, 1878 (Chemical News, vol. xxxviii., p. 237). The paper is published *in extenso* in the *Archives des Sciences Physiques et Naturelles*, vol. lxiii., pp. 99 and 101.

[†] *Comptes Rendus*, October 14, 1878; Chemical News, vol. xxxviii., p. 202.

[‡] It is this band which M. Delafontaine points out as characteristic of Philippium. I consider that indication an unfortunate one, for, according to all the observations I am acquainted with, erbium gives rise to a much narrower ray at the same place.

[§] *Comptes Rendus*, June 9, 1879; Chemical News, vol, xxxxi., pp. 286, 298.

[*] *Archives des Sc. Phys. et Nat.*; *loc. cit.*, p. 99.

[†] *Archives des Sc. Phys. et Nat.*, 1878, t. lxiv., p. 101. M. Marignac also pointed out some other reasons which would lead us to suppose that these products were complex mixtures.

of at least two distinct oxides in erbia, I had examined the absorption spectra of salts of erbium of different composition. All these compounds, including those extracted from euxenite (a mineral chemically analogous to samarskite), but not those obtained from samarskite, gave the same rays and the same relative intensities as the chloride of erbium used for my old diagram (*Spectres lumineux*, Pl. xv.). The salts of erbia obtained from samarskite by M. Demarçay and Prof. Lawrence Smith present indeed the rays of my drawing, but with a marked alteration of relative intensities. The chief characteristic of samarskite-erbia is that—First, the green ray, $\lambda = 536·3$, is much more intense than its neighbour, $\lambda = 540·9$, whilst in the other erbias the predominance of $\lambda = 536·3$ is very slight; second, the red ray, $\lambda = 640·4$, is as strong, or even stronger, than its neighbour, $\lambda = 653·4$, whilst in the other erbias $\lambda = 653·4$ predominates greatly over $\lambda = 640·4$. The other variations of intensity are less striking.

If ordinary erbia is a mixture of several analogous earths, is it not strange to see specimens of very different productions possessing a composition, the constancy of which is shown by the identity of the spectra? On the other hand, the presence of foreign bodies, the nature and even the quantity of the acids have often a very marked influence on the absorption-bands. We might then, strictly, still admit the unity of erbia, and suppose that the special distribution of intensities in the spectrum of samarskite-erbia is due to the presence, in samarskite, of a larger proportion of some principle, known or unknown, different from the earths properly so-called, but still undetermined.

These objections having been submitted to M. Soret, that eminent physicist gave reasons in favour of the existence of his earth X, which led me to undertake the following research:—

I selected two rich samples of erbia. One, A, almost pure, prepared by M. Demarçay, gave with great exactitude the spectrum of my drawing. The other, B, was a raw product, rich in yttria, obtained by Prof. Lawrence Smith's labours on samarskite, of which it presented the characteristic spectral type.

A and B were separately submitted to fractionated precipitations with ammonia. One of the extreme products of A soon showed a tendency to resemble the spectral type of B, whilst one of the extremes of B in like manner approached the type of A, the direction of the modifications being the same in the two series.

With ammonia the operation worked very slowly, but by the methodical use of the potassium and sodium sulphates in the cold, and by the aid of heat, the effect was analogous, and far more rapid. A few operations were sufficient to extract from A an erbia spectrally similar to that of samarskite, and from B an earth possessing a spectrum almost exactly like that of my old drawing.

These results seem to decide the question in favour of M. Soret's ideas, and agree with the important researches recently published by MM. Clève and Thalèn. Moreover, before my opinion on such a delicate question is settled, I should like to wait for fuller information, and the completion of the work begun, confining myself at present to publishing the above simple facts of observation.—*Comptes Rendus*, September 15, 1879.

ON THE

CHEMICAL COMPOSITION OF A NODULE OF OZOKERITE FOUND AT KINGHORNNESS.*

By W. IVISON MACADAM, F.C.S., &c.,
Lecturer on Chemistry, Edinburgh.

The nodule to which this paper refers was discovered at Kinghornness during the excavations rendered necessary by the fortifications at present being raised for the defence of the Firth of Forth. The material was enclosed in a nest or nodule, and was found at a depth of 15 feet from the surface of the ground, and embedded 5 feet in hard trap rock. The rock in which the nodule was obtained was sound, no crack or fissure being observable for several feet round the nest. At a point some distance below the nodule the section shows a series of small veins or fissures running through the rock in various directions, and averaging ⅜ of an inch in breadth. The analysis of this rock gave the following results, calculated to percentages.

(1.) On treating the pulverised sample with hydric chloride (HCl), and subjecting the mixture to a prolonged low heat, it was found that 29·73 per cent of the substance dissolved in the acid. The detailed results of the analysis of this solution are as follows:—

	Per cent.
Ferric oxide (Fe_2O_3)	11·45
Aluminic oxide (Al_2O_3)	3·63
Calcic oxide (CaO)	3·70
Magnesic oxide (MgO)	0·37
Potassic oxide (K_2O) .. .. Sodic oxide (Na_2O)	0·13
Carbonic anhydride (CO_2)	8·17
Sulphuric anhydride (SO_3)	0·21
Silica from soluble silicates (SiO_2)	2·07
Total soluble in acids	29·73
Insoluble in acids and silicates	70·27
	100·00

(2.) The portion insoluble in acids was then fused with a flux, and the following results obtained from the after solution in acids:—

	Per cent.
Ferric oxide (Fe_2O_3)	9·92
Aluminic oxide (Al_2O_3)	5·36
Calcic oxide (CaO)	8·17
Magnesic oxide (MgO)	5·67
Silica from silicates, &c. (SiO_2)	41·12
Total from fused portion	70·24
Soluble in acids	29·73
	99·97

The rocks lying next to the trap were also analysed, and gave results as stated below:—

I. *Soluble in Hydric Chloride* (HCl).

	No. 2. Rock above Trap.	No. 3. Rock below Trap.	No. 4. Same as 2, but nearer the surface ground.
Ferric oxide (Fe_2O_3)	21·37	31·48	15·78
Aluminic oxide (Al_2O_3)	4·06	4 59	7·92
Calcic oxide (CaO)	2·83	3·11	2·19
Magnesic oxide (MgO)	2·98	4·23	2·47
Potassic oxide (K_2O) .. .. Sodic oxide (Na_2O)	0·98	0·82	1·48
Carbonic anhydride (CO_2) ..	5·19	6·01	4·62
Sulphuric anhydride (SO_3) ..	0·32	0·28	1·62
Sulphur (S)	0·13	0·16	2·17
Silica (SiO_2) from sol. silicates	2·08	2·23	3·95
Moisture	3·22	3·41	3·14
Total soluble in acid	43·16	56·32	44·34
Insoluble in acid	56·84	43·68	55·66
	100·00	100·00	100·00

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* Read before the British Association for the Advancement of Science (Section B.), Sheffield, 1879.

II. *Matter Insoluble in Hydric Chloride* (HCl) *fused with Flux and then treated with Acid.*

	No. 2. Rock above Trap.	No. 3. Rock below Trap.	No. 4. Same as 2, but nearer the surface of ground.
Ferric oxide (Fe_2O_3)..	5·28	4·84	7·04
Aluminic oxide (Al_2O_3)	3·48	4·12	7·76
Calcic oxide (CaO)	2·15	1·18	0·78
Magnesic oxide (MgO)	1·03	0·28	0·24
Silica (SiO_2) from silicates, &c.	44·68	33·12	39·72
Total from fused portion.. ..	56·62	43·54	55·54
Soluble in acids..	43·16	56·32	44·34
	99·78	99·86	99·88

The nodule when broken consisted of—

(1.) An outer coating of hard rock;
(2.) An inner lining of calcite crystals; and
(3.) Centre nodule of bituminous matter.

When first brought to light the calcite crystals were almost black in colour, due to a certain amount of the bituminous matter, but this slowly evaporated, and left the crystals pure white in colour. The analyses of these crystals of calcite yielded the following results:—

	Black Crystals containing Bitumen.	White Crystals.
Calcic carbonate ($CaCO_3$) ..	96·76	98·11
Ferrous carbonate ($FeCO_3$) ..	0·19	0·21
Magnesic carbonate ($MgCO_3$)	0·31	0·33
Silica (SiO_2)	1·06	1·22
Bituminous matter..	1·68	0·13
	100·00	100·00

The lower veins or fissures were also calcite-lined, and contained within this coating the bituminous matter.

Besides the nodule found at Kinghornness, another nodule of a similar character was obtained on the Island of Fuchkeith, embedded in solid trap, 10 feet from the surface, and a small spring of water on that island smells and tastes distinctly of paraffin products.

The Kinghornness nodule has a distinct bituminous odour; is a lustrous black; amorphous, soft solid, easily cut with the nail, and pliable between the fingers. The specific gravity is 970 (water 1000), so that the nodule floats upon water. It fuses at 176° F., and becomes solid on cooling. Experiments with the various solvents upon the bituminous material showed that water and ordinary acids had practically no action whatever. Alcohol, both hot and cold, had a very slight solvent power, but ether dissolved a considerable proportion, giving a brown solution, and turpentine readily acted upon the substance, yielding a deep brown-black solution. The ethereal liquid had a fine iridescent green colour when viewed by reflected light. The substance of the nodule readily burns when lighted, giving a strongly luminous flame. The analysis of the contents of the nodule gave as follows:—

	Per cent.
*Volatile organic matter	99·38
Ash or mineral matter	0·61
	99·99

Volatile gaseous matter given off below 212° F.=5·961 per cent.

When distilled at a bright cherry-red heat, 26·57 grs. being used, the results gave—

		Grains.
	Volatile matter	15·93
Coke, 10·64 grs.	Fixed carbon	10·48
	Ash (mineral matter)	0·16
		26·57

These results calculated to the percentages give—

		Per cent.
	Volatile matter	59·955
Coke, 40·041 p.c.	Fixed carbon..	39·431
	Ash (mineral matter)	0·610
		99·996

The coke left behind after this treatment was a hard, black, shining, porous mass, and the ash obtained by incinerating it was pure white, and principally consisted of calcic carbonate ($CaCO_3$) and silica (SiO_2).

The material was afterwards submitted to destructive distillation at a black-red heat, when the substance was found to split up into six distinct parts—four distillates, a coke, and a volatile non-condensable gas. In this operation 58·29 grains were used, and yielded—

	Grains.
First distillate	5·65
Second distillate	11·35
Third distillate	21·33
Fourth distillate	14·72
Total volatile condensable products ..	53·05
Coke	2·28
Uncondensable gases..	2·96
Total	58·29

Calculated to percentages the results stand—

	Per cent.
First distillate	9·694
Second distillate	19·471
Third distillate	36·592
Fourth distillate..	25·253
Volatile condensable products	91·010
Coke	3·911
Uncondensable gas	5·078
	99·999

When first heated the substance fused and frothed, and on the further application of heat gave the first distillate, which was of a grey colour, somewhat mobile, and had a disagreeable odour. The second distillate was black in colour, fully more mobile than the first distillate, and also possessed a most disagreeable odour. The third portion was more mobile than the second, had a yellow colour and a marked paraffin odour. The fourth distillate was obtained after raising the heat, had a yellow-red colour, was liquid whilst hot, but turned solid on cooling, and had also a paraffin odour. The uncondensable gaseous matter readily burned on the application of a white light, gave a pale non-luminous flame, and possessed all the chemical properties of methane or marsh-gas (CH_4). The carbon left in the retort, added to the amount of uncondensable gas, gives 8·989 per cent, and on calculating the uncondensable gas into ethylene or olefiant gas (C_2H_4) the result obtained is 8·886, or nearly identical.

These results go far to show that the bituminous-like matter of the nodule consists of a member or members of the olefine ($ClCH_2$) series of organic compounds, a point which is further stengthened by the fact that the carbon and hydrogen in the original substance are contained therein in almost exactly the necessary proportions to form an olefine.

It is probable that the source of the contents of the nodule lies in one of the coal or shale beds abounding in the district, and that a low internal heat has dissolved the material from its parent stratum. That the heat was low, or certainly not above a cherry-red, is certain, else the olefine would have been split up into a member of the methane or CH_4 group of organic substances, accompanied by a deposition of free carbon.

ON THE

SEPARATION OF PHOSPHORUS AND IRON, ESPECIALLY WITH REFERENCE TO THE MANUFACTURE OF STEEL.*

By THOMAS BLAIR.

All recent improvements in the manufacture of iron and steel sink into comparative insignificance before the successful production of merchantable steel from phosphoretic pig-iron, and it has been thought advisable that the writer should prepare a short review of the whole subject of the purification of iron from phosphorus.

Pig-iron being in nearly all cases the raw material from which iron or steel in the finished state is prepared, it is necessary to know the amount of phosphorus it contains, its suitability for various purposes being dependent upon this; and, as a necessary consequence, the selection of ores for smelting depends mainly on the same fact, viz., their content of phosphorus.

In the following table the percentage of phosphorus existing in ores of various kinds is given, the first two being suitable for the manufacture of steel and fine wrought-iron, the others not:—

	Iron Per cent.	Phosphorus Per cent.
1. Spanish hæmatite	50·63	0·01
2. Cumberland hæmatite.. ..	58·00	0·01
3. Cleveland ore (raw)	30·00	0·50
4. Northamptonshire ore ..	39·00	0·40
5. Lincolnshire ore	30·00	0·35 to 0·40
6. Clay-band, or argillaceous ironstone	30·00	0·20

In the pig-iron made from such ores, the amount of phosphorus may be previously estimated by calculating the quantity of ore required to produce a ton of pig-iron. The following gives the percentages of phosphorus usually found in pig-iron smelted from the above ores:—

1. Spanish pig	0·03 p.c.
2. Cumberland pig..	0·03 ,,
3. Cleveland pig	1·50 ,,
4. Northamptonshire pig	1·30 ,,
5. Lincolnshire pig	1·25 ,,
6. Clay-band, or "Mine" pig ..	0·50 ,,

In the products of purification, the following are the percentages of phosphorus usually found:—

	Phosphorus per cent.
1. Refined iron	0·35
2. Puddled iron (common)..	0·08
3. ,, ,, (best)	traces
4. Crucible steel	trace to 0·03
5. Bessemer or Siemens's (rails) ..	0·05 to 0·20
6. ,, ,, (soft) ..	0·02 to 0·06

It will be obvious from these figures that, if the purifying processes are unable to deal rapidly and energetically with phosphorus, only such pig-irons as Nos. 1 and 2 in the above table can safely be employed, since the presence of phosphorus in steel or wrought-iron, in quantities greater than the above, unfit them more than does any other element for most of the purposes for which they are intended, inasmuch that its presence in excess renders the metal hard and brittle, and although its malleability does not appear to be affected, yet in the cold it is exceedingly brittle. These faults are intensified when the other elements usually existing in wrought-iron or steel are present in larger proportions than usual. Mr. Hackney states that "Steel for rails if nearly free from phosphorus, and at the same time containing little silicon, is not made too hard to be safe by even 0·6 or 0·7 per cent of carbon; yet if the phosphorus amounts to 0·05 or 0·06 per cent, the carbon cannot be prudently allowed to exceed 0·45 per cent, and steel rails containing 0·1 per cent of phosphorus should never contain more than 0·3 per cent of carbon, and so on until when the carbon is kept down to 0·16 per cent. Steel containing 0·3 per cent of phosphorus will yet make serviceable rails, and that containing 0·15 per cent will make excellent tough boiler-plates, that may be bent double cold after heating to redness and quenching in water; while, of course, metal free, or nearly free, from phosphorus is still softer and tougher, more, in fact, like copper than any commonly known variety of iron."*

It will thus be seen that only those pig-irons in which the phosphorus is considerably less than 0·1 per cent can be employed in the manufacture of steel in the Bessemer, Siemens, or crucible processes, in which no elimination of this objectionable element takes place.

Unfortunately the bulk of the iron ores raised in this country, as well as in most other iron-producing countries, or in districts adjacent to coal-fields, contain so much phosphorus as to unfit them for the production of iron suitable for these just-named processes, such crude iron being smelted from purer and scarcer ores, which are often more expensive to raise, or which occur at great distances from iron-producing centres.

It would naturally occur to many that it might be feasible to separate the phosphorus from the ore previous to smelting; this has actually been done. Such processes are based upon the following chemical reactions:—Phosphorus exists in iron ores, either as lime or iron phosphate. Lime phosphate is soluble in a strong solution of sulphurous acid, but is not acted upon by ammonium sulphide. Iron phosphate is decomposed by ammonium sulphide, but is not soluble acid, and is also rendered soluble in water when fused with common salt.

Some years ago M. Jacobi, manager of Kladno Works, Prague, Austria, succeeded in extracting the lime phosphate very completely from ores in which it existed in quantity, by treating the coarsely-powdered ore with aqueous sulphurous acid; on boiling the solution the acid was recovered and re-condensed in coke towers, whilst the phosphate of lime was precipitated. This substance was said to fetch a price which amply repaid the cost of the process. But when it is remembered that a modern blast-furnace consumes from 600 to 1000 tons of ore per week, it will be evident that the magnitude of the plant required will be an effectual bar to its adoption; and that, further, as the ore treated in such processes requires to be pulverised, only a small proportion of the ore so treated could be used in the blast furnace.

In the earlier days of iron smelting, the little Catalan forges, still used here and there on the sides of the Pyrenees, had but imperfect powers of reduction, and large quantities of oxide of iron passed off into the slag, carrying away the whole of the phosphorus, so that iron of excellent quality was directly produced from very impure ores. The same ores smelted in a blast-furnace, where the powers of reduction are perfect, gave irons rich in phosphorus, with no waste of iron in the slags. In fact the blast-furnace is so perfect in its reducing powers that it reduces all the undesirable elements, which it is the object of subsequent oxidising processes to eliminate, the smelting process being essentially one of reduction, whilst all purifying processes are necessarily oxidising.

Dr. Percy aptly describes the blast-furnace process as "the indirect extraction of iron in the state of *cast-iron*, from the ore." Mr. I. Lowthian Bell thus tersely describes the theory of smelting:—

"Exposed to the intensely deoxidising agency of the blast-furnace, portions of the silica, and probably the greater portions of the sulphur compounds, lose their oxygen, and are taken up wholly or in part by the reduced iron. Practically, however, it may be assumed that all

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* Read before the British Association for the Advancement of ience (Section B.), Sheffield, 1879.

* This statement, however, seems open to question, since extra soft steel seldom contains more than 0·06 per cent of phosphorus.

the phosphoric acid in the minerals is decomposed during the smelting process, and in consequence all its phosphorus is to be found in the pig metal. In the metallic product of the blast-furnace, carbon, derived either directly from the fuel, or from dissociated carbonic oxide, is invariably present. For our present purpose we may therefore regard pig-iron as a compound of carbon, silicon, sulphur, and phosphorus, and the metal itself."

Experiments made by Mr. Stead seem to prove that phosphorus exists in pig-iron as phosphide (Fe_4P) in a state of solution, or intimate diffusion throughout the mass, he having actually squeezed out a compound very rich in phosphorus from viscous pig-iron, an examination of which proved this to be the state of combination.

The prospects of successful removal of phosphorus in the blast-furnace are very discouraging. Attempts have been made to flux it off by adding salt, magnesian limestone, and other bodies, but without the smallest measure of success. Low temperatures and presence of oxide of iron in the slag being essential conditions for its removal, it is obvious that the very perfection of the blast-furnace renders phosphorus elimination impossible. When these conditions do occur, that is in disordered working, some phosphorus is actually slagged off.

Unpurified pig-iron is used only for castings, of which however, an enormous tonnage is annually made. It is stated that for small articles, where no great amount of strength is required, phosphoretic pig is more suitable, owing to the greater fluidity which phosphorus confers upon it. For all other purposes, pig-iron has to undergo some operation of refining in order to arrive at a degree of strength, which could only be attained with cast-iron by employing cumbrous masses.

Up to the time of Bessemer's invention, the puddling process was the principal one in use for this purpose. Before the invention of this process by Henry Cort, exactly a century ago, malleable iron was only obtainable in small quantities by wasteful and expensive processes, similar to the Catalan, Corsican, or Osmund. All of them depending for their success upon the fact that when molten iron is kept sufficiently long, and at a proper temperature, in intimate contact with oxide of iron, the whole of the phosphorus is removed, after the silicon has gone, and before, concurrently with, or after the carbon, according to circumstances to be hereafter explained.

It was formerly the practice to treat all pig-iron intended for puddling in a refinery, or "running-out" fire, as a preliminary to puddling. This is now, however, to a very great extent discontinued, except for the manufacture of special qualities of wrought-iron. Its chief merit appears to be that it removes most of the silicon. The process consists in melting under coke, by means of a blast of air impinging at an angle of about 45°, about one ton of pig-iron; oxide of iron being added in the shape of hammer or roll-scale. About one-and-a-half hours is the time occupied in melting; another half-hour is occupied in blowing air upon the bath of molten metal.

[A diagram accompanies the author's paper, in which was given the curves representing the removal of carbon, silicon, and phosphorus from the molten metal; the abscissæ representing times, and the ordinates percentages of the elements removed. This diagram is based on the following analyses given by Mr. I. Lowthian Bell in his paper on this subject, read before the Iron and Steel Institute in 1877 :—

	Carbon Per cent.	Silicon Per cent.	Phosphorus Per cent.
Bowling cold-blast pig.. ..	3·686	1·255	0·565
After melting in the refinery	3·510	0·575	0·557
10 minutes after fusion ..	3·707	0·478	0·537
20 ,, ,, ..	3·644	0·273	0·530
28 ,, ,, ..	3·544	0·154	0·509
Refined metal..	3·342	0·130	0·490]

The refined plate, or as is now most commonly the case, the crude pfg-iron, is charged into the puddling furnace in quantities of about 4 cwts. (the modern mechanical furnaces take quantities up to one ton), the bottom and sides of the furnace being previously lined with some variety of oxide of iron. In about half an hour the charge is melted, and the molten metal soon commences to boil, owing to the reaction between the oxide of iron and the carbon, jets of carbonic oxide gas being projected through the bath, burning with a blue flame on the surface, and a considerable quantity of slag is formed, consisting of ferrous ortho-silicate. The bath is diligently stirred by the puddler, or in the case of mechanical furnaces by the rotation of the furnace, in order to effect intimate contact between the molten iron and the oxides. As the carbon disappears, the iron becomes less and less fusible, and is subsequently removed in several balls of 80 to 100 pounds each, which are then forcibly compressed by hammering or squeezing to expel the intermingled slag and to consolidate the mass.

It will be well here to examine with care what takes place in these two processes, in order to understand the chemistry of the elimination of phosphorus in the Bessemer process.

First, the oxygen of the oxides, or of the air, or both, rapidly removes the most readily oxidisable element, silicon. Phosphorus is oxidised and passes off into the slag, most probably as tribasic phosphate of iron. Percy suggests that its removal takes place by liquation, or "sweating out," when by removal of the carbon the iron begins to thicken, or "comes to nature;" but the experiments of Bell, Stead, and others point conclusively to the fact that molten oxide actually washes out the phosphorus, oxidising it at the same time. It is worthy of notice that if the slag is not tapped out of the furnace the phosphorus is reduced and passes again to a considerable extent into the iron at the end of the operation.

The following are analyses of slags from the refinery and puddling processes :—

	Refinery p.c.	Puddling p.c.
Iron	50·96	49·65
Silica..	25·77	29·60
Phosphorus	1·37	3·50

It may be here noted that the addition of fluor-spar with titaniferous ore (known as Henderson's process) seems greatly to expedite the removal of phosphorus during puddling.

Bessemer Process.—In 1856 Sir Henry (then Mr.) Bessemer read a paper before this Association at Cheltenham, on a new process for manufacturing steel cheaply on the large scale. Up to this time the bulk of the steel made in the world was produced by the crucible method, by melting cemented, or carbonised puddled Swedish iron with the addition of manganese. His process has made such rapid progress that now the great majority of the steel made in the world is produced by its means, and it is generally so well understood that it requires a very brief description here.

Pig-iron of the following approximate composition :—

Graphite	2·90 p.c.
Combined carbon	0·50 ,,
Silicon	2·00 ,,
Sulphur	0·03 ,,
Phosphorus	0·05 ,,
Manganese	0·60 ,,

melted in cupolas or in reverberatory furnaces, or run direct from the blast-furnace, is run into a movable converter made of boiler-plate iron, lined 9 inches or more with gannister, and mounted on trunnions, so as to move through about three-quarters of a revolution by hydraulic machinery. When in position for blowing, the tuyeres are at the bottom of the vessel, and numerous jets of air are forced through the bath of metal at a pressure of from 15 to 20 lbs. to the square inch, according to the depth or liquidity of the bath.

As in the puddling process, the silicon is rapidly removed, and subsequently the carbon. The phosphorus in the steel, however, is slightly more than that in the pig-iron used, owing to the fact that there is some waste of iron and none of phosphorus. A more concentrated solution may be said to be formed.

In a period of from ten to about thirty minutes, according to quantity treated, and proportion of silicon, carbon, or manganese present, the carbon is reduced to 0·1 per cent or less. The flame then "drops," or suddenly diminishes in size, while at the same moment the lines in the spectrum, due to the oxidation of carbon, are seen to suddenly disappear. The product is then, if cooled, a soft metal, of a composition very closely approximating to that of wrought-iron, but so spongy that it is valueless. By the addition of an alloy of iron, carbon, and manganese, well known as spiegeleisen or ferro-manganese, the dissolved or occluded gases are taken up, and a sufficient quantity of carbon and manganese restored to the bath to render the resulting steel hard or soft as desired. It is only right to add here that this necessary addendum to Bessemer's brilliant process originated with R. F. Mushet.

Owing to the rapid oxidation of silicon, carbon, and manganese the temperature and fluidity of the bath rapidly increase. The initial temperature of the molten pig being 1500° C., that of the steel, as poured, is about 2500° C., and a piece of thick platinum wire rapidly fuses in a stream of the steel.

It is now a matter of history that Sir Henry Bessemer avowedly thought at first that any pig-iron was suitable for his process, and that he had ultimately to fall back upon pig almost free from phosphorus.

In the Siemens, and Siemens-Martin process also, which there is not time now to describe, such non-phosphoretic irons are also a necessity. Thus both these eminently useful processes preclude the use of those irons made from the bulk of native ores, which, as already stated, contain phosphorus in notable quantity. The elimination of this element in these two processes, which produce the bulk of steel made in the world, was therefore always a necessity, but became a burning question when the iron rail trade died, bequeathing to the iron masters mountains of ore, hosts of idle blast- and puddling-furnaces and rolling-mills, the owners of which had no alternative but to contend with and overcome, if possible, that perverse but ubiquitous principle of nature which renders the attainments of objects most desirable extremely difficult.

The first to step into this ugly breach was Mr. Isaac Lowthian Bell, who gave to the world in 1877 the outcome of his careful study, and experiments on the separation of carbon, silicon, and phosphorus, as effected in the processes already described.

Mr. Bell's efforts were directed towards the attainment of a practical method of separating the phosphorus from Cleveland iron to such an extent as to permit of its use in the manufacture of steel, and also to make puddled iron of a quality superior to that obtained by the ordinary puddling process.

Pig-iron taken direct from the blast-furnace was treated in a suitable apparatus with melted oxide of iron, and it was found that whilst 11 per cent only of the carbon was removed, as much as 91 per cent of the phosphorus went; or in exact figures the pig-iron contained—

Carbon	3·637 p. c.
Phosphorus	1·351 ,,

The average composition of four samples so purified was—

Carbon	3·227 p. c.
Phosphorus	0·109 ,,

By prolonging the operation the whole of the carbon can be also eliminated, but that there is a slight increase in the phosphorus at the end.

This purified metal, after puddling, piling, and rolling, gave a finished bar containing—

Silicon	0·079 p. c.
Sulphur	0·007 ,,
Phosphorus	0·040 ,,

This analysis corresponds to that of a finished bar of high quality.

It may be here noted that Mr. Stead had on the small scale found that Cleveland iron was purified from its phosphorus, to a great extent, by violently shaking it with fused oxide of iron in a closed crucible. Mr. Stead also over-blew pig-iron in the Bessemer converter, but owing to the fact that his lining was silicious instead of basic, his experiment was unsuccessful.

One of Mr. Bell's proposals was to use the Bessemer converter as a means of rapidly removing silicon and then puddling the product; another was to make use of the Godfrey-Howson puddling-furnace in which to treat molten pig-iron with fused oxide of iron, or fused iron slags or iron ores.

The phosphorus removed from the iron naturally passes into the slag formed, so that oxide or slag containing 1·5 per cent of phosphorus before the operation, was found to contain 3 or 4 per cent afterwards.

The most noteworthy disadvantage of Mr. Bell's process, as compared with that of Thomas and Gilchrist, to be hereafter described, seems to be that it would only be capable of dealing with small quantities at a time, and that a very extensive plant would be required; whilst the other deals with 6 or 8 tons at one operation, and only requires slight modifications of the ordinary Bessemer plant.

(To be contin[n]ued.)

THE ACTION OF HEAT *IN VACUO* ON METALS.*

By T. A. EDISON.

In the course of my experiments on electric lighting I have developed some striking phenomena arising from the heating of metals by flames and by the electric current, especially wires of platinum, and platinum alloyed with iridium. These experiments are in progress.

The first fact observed was that platinum lost weight when heated in a flame of hydrogen, that the metal coloured the flame green, and that these two results continued until the whole of the platinum in contact with the flame had disappeared. A platinum wire four-thousandths of an inch in diameter, and weighing 306 m.grms., was bunched together and suspended in a hydrogen flame. It lost weight at the rate of a fraction less than 1 m.grm. per hour as long as it was suspended in the flame. When a platinum wire is stretched between two clamping posts, and arranged to pass through a hydrogen flame, it is coloured a light green; but when the temperature of the wire is raised above that of the flame, by passing a current through it, the flame is coloured a deep green. To ascertain the diminution in the weight of a platinum wire when heated by the electric current, I placed between two clamping posts a wire five-thousandths of an inch in diameter, and weighing 266 m.grms. This wire, after it was brought to incandescence for twenty minutes by the current, lost 1 m.grm. The same wire was then raised to incandescence; for twenty minutes it gave a loss of 3 m.grms. Afterward it was kept incandescent for one hour and ten minutes, at which time it weighed 258 m.grms.—a total loss of 8 m.grms. Another wire, weighing 343 m.grms., was kept moderately incandescent for nine consecutive hours, after which it weighed 301 m.grms., showing a total loss of 42 m.grms. A platinum wire twenty-thousandths of an inch in diameter was wound in the form of a spiral one-eighth of an inch in diameter and one-half an inch in length. The two ends of the spiral were secured to clamping posts, and the whole apparatus was covered with a glass shade

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* A Paper read before the American Association for the Advancement of Science; Saratoga Meeting.

$2\frac{1}{2}$ inches in diameter and 3 inches high. Upon bringing the spiral to incandescence for twenty minutes that part of the globe in line with the sides of the spiral became slightly darkened; in five hours the deposit became so thick that the incandescent spiral could not be seen through the deposit. This film, which was most perfect, consisted of platinum, and I have no doubt but that large plates of glass might be coated economically by placing them on each side of a large sheet of platinum, kept incandescent by the electric current. This loss in weight, together with the deposit upon the glass, presented a very serious obstacle to the use of metallic wires for giving light by incandescence, but this was easily surmounted after the cause was ascertained. I coated the wire forming the spiral with the oxide of magnesium, by dusting upon it finely powdered acetate of magnesium: while incandescent the salt was decomposed by the heat, and there remained a strongly adherent coating of the oxide. This spiral so coated was covered with a glass shade, and brought to incandescence for several minutes; but, instead of a deposit of platinum upon the glass, there was a deposit of the oxide of magnesia. From this and other experiments I became convinced that this effect was due to the washing action of the air upon the spiral; that the loss of weight in and the colouration of the hydrogen flame were also due to the wearing away of the surface of the platina to the attrition produced by the impact of the stream of gases upon the highly incandescent surface, and not to volatilisation, as commonly understood; and I venture to say, although I have not tried the experiment, that metallic sodium cannot be volatilised in high vacua by the heat derived from incandescent platinum; any effect that may be produced will be due to the washing action of the residual air. After the experiment last described I placed a spiral of platinum in the receiver of a common air-pump, and arranged it in such a manner that the current could pass through it, while the receiver was exhausted. At a pressure of 2 millimetres the spiral was kept at incandescence for two hours before the deposit was sufficient to become visible. In another experiment, at a higher exhaustion, it required five hours before a deposit became visible. In a sealed glass bulb, exhausted by a Sprengel pump to a point where a quarter of an inch spark from an induction-coil would not pass between points 1 millimetre apart, was placed a spiral, the connecting wires passing through the glass. This spiral has been kept at the most dazzling incandescence for hours without the slightest deposit becoming visible.

I will now describe other and far more important phenomena observed in my experiments. If a short length of platinum wire one-thousandth of an inch in diameter be held in the flame of a Bunsen burner, at some part it will fuse, and a piece of the wire will be bent at an angle by the action of the globule of melted platinum; in some cases there are several globules formed simultaneously, and the wire assumes a zigzag shape. With a wire four-thousandths of an inch in diameter this effect does not take place, as the temperature cannot be raised to equal that of the smaller wire, owing to the increased radiating surface and mass. After heating, if the wire be examined under a microscope, that part of the surface which has been incandescent will be found covered with innumerable cracks. If the wire be placed between clamping posts, and heated to incandescence for twenty minutes, by the passage of an electric current, the cracks will be so enlarged as to be seen with the naked eye; the wire, under the microscope, presents a shrunken appearance, and is full of deep cracks. If the current is continued for several hours these effects will so increase that the wire will fall to pieces. This disintegration has been noticed in platina long subjected to the action of a flame by Prof. John W. Draper. The failure of the process of lighting invented by the French chemist Tessie du Motay, who raised sheets of platinum to incandescence by introducing them into a hydrogen flame, was due to the rapid disintegration of the metal. I have ascertained the cause of this phenomenon, and have succeeded in eliminating that which produces it, and in doing so have produced a metal in a state hitherto unknown, and which is absolutely stable at a temperature where nearly all substances melt or are consumed; a metal which, although originally soft and pliable, becomes as homogeneous as glass and as rigid as steel. When wound in the form of a spiral it is as springy and elastic when at the most dazzling incandescence as when cold, and cannot be annealed by any process now commonly known, for the cause of this shrinking and cracking of the wire is due entirely to the expansion of the air in the mechanical and physical pores of the platinum, and the contraction upon the escape of the air. Platinum as sold in commerce may be compared to sandstone, in which the whole is made of a great number of particles with many air spaces. The sandstone upon melting becomes homogeneous and no air spaces exist.

With platinum or any metal the air spaces may be eliminated, and the metal made homogeneous by a very simple process. This process I will now describe. I had made a large number of platinum spirals, all of the same size and from the same quality of wire; each spiral presented to the air a radiating surface of three-sixteenths of an inch; five of these were brought by the electric current up to the melting-point, the light was measured by a photometer, and the average light was equal to four standard candles for each spiral just at the melting-point. One of the same kind of spirals was placed in the receiver of an air-pump, and the air exhausted to 2 millimetres; a weak current was then passed through the wire, to slightly warm it for the purpose of assisting the passage of the air from the pores of the metal into the vacuum. The temperature of the wire was gradually augmented, at intervals of ten minutes, until it became red. The object of slowly increasing the temperature was to allow the air to pass out gradually and not explosively. Afterward the current was increased at intervals of fifteen minutes. Before each increase in the current the wire was allowed to cool, and the contraction and expansion at these high temperatures caused the wire to weld together at the points previously containing air. In one hour and forty minutes this spiral had reached such a temperature without melting that it was giving a light of twenty-five standard candles, whereas it would undoubtedly have melted before it gave a light of five candles had it not been put through the above process. Several more spirals were afterwards tried, with the same result. One spiral, which had been brought to these high temperatures more slowly, gave a light equal to thirty standard candles. In the open air this spiral gave nearly the same light, although it required more current to keep it at the same temperature. Upon examination of these spirals, which had passed through the vacuum process, by the aid of a microscope no cracks were visible; the wire had become as white as silver, and had a polish which could not be given it by any other means. The wire had a less diameter than before treatment, and it was exceedingly difficult to melt in the oxy-hydrogen flame. As compared with untreated platinum, it was found that it was as hard as the steel wire used in pianos, and that it could not be annealed at any temperature.

My experiments with many metals treated by this process have proved to my satisfaction, and I have no hesitation in stating that what is known as annealing of metals to make them soft and pliable is nothing more than the cracking of the metal. In every case where a hard drawn wire had been annealed a powerful microscope revealed myriads of cracks in the metal. Since the experiments of which I have just spoken I have, by the aid of Sprengel mercury pumps, produced higher exhaustion, and have, by consuming five hours in excluding the air from the wire and intermitting the current a great number of times, succeeded in obtaining a light of eight standard candles from a spiral of wire with a total radiating surface of 1-32nd of an inch, or a surface about equal to one grain of buckwheat. With spirals of this small size which have not passed through the process, the average amount of light given out before melting is less than one standard candle. Thus I am enabled, by the increased capacity of platinum, to withstand high temperatures to employ small radiating surfaces, and thus reduce the energy required for candle light. I can now obtain eight separate jets, each giving out an absolutely steady light, and each equal to sixteen standard candles, or a total of 128 candles, by the expenditure of 30,000 foot-pounds of energy, or less than one-horse power. As a matter of curiosity I have made spirals of other metals, and excluded the air from them in the manner stated. Common iron wire may be made to give a light greater than platinum not heated. The iron becomes as hard as steel, and just as elastic. Nickel is far more refractory than iron. Steel wire used in pianos becomes decarbonised, but remains hard, and becomes the colour of silver. Aluminum melts only at a white heat.

In conclusion, it may be interesting to state that the melting-points of many oxides is dependent on the manner of applying the heat; for instance, pure oxide of zirconium does not fuse in the flame of the oxy-hydrogen blowpipe, while it melts like wax and conducts electricity when on an incandescent platinum spiral which is at a far lower temperature; on the other hand, oxide of aluminum easily melts in the oxy-hydrogen flame, while it only vitrifies on the platinum spiral.

A NEW METHOD OF PREPARING SULPHURETTED HYDROGEN.

By J. FLETCHER, F.C.S., London and Paris.

Any mode by which the preparation of this useful gas can be rendered easier, and the unpleasantness of its manipulation diminished, will no doubt be welcomed by analysts: I therefore make no apology for submitting the results of some experiments made after reading a suggestion in some of the scientific journals, perhaps your own, but the name does not at the moment occur to me.

The plan is simply to fuse in a small glass flask sulphur and solid paraffin, leading the resulting gas by means of a perforated cork, india-rubber, and glass tube directly into the solution to be tested. The first gases are not sulphuretted, but when the mixture has been thoroughly fused and mixed the sulphuretted hydrogen passes over abundantly.

The advantage of the process is that the moment the flame of the lamp is removed the evolution of gas ceases, and the little apparatus can be laid aside without fear of creating offensive smells. When used again, the gas passes at once when sufficiently heated.

A washing bottle seems unnecessary. I passed the gas for an hour through such a bottle, and the water, although most strongly impregnated with the gas, was fairly clear and limpid, showing only the usual appearances.

There are a few precautions to be taken. The mixture is inclined to bump when strongly heated, but a few pieces of broken tobacco-pipe shank prevent that. Care must be taken that when the lamp is removed, and the gas ceases to pass, that none of the solution is sucked back into the bulb; it is very easily prevented. A very strong heat should not be applied, as then distillations would commence and the product condense in the tube.

I believe the process to be a simple, cleanly, and elegant substitute for the old methods, and particularly well suited for small and private laboratories. How it would work in large ones I would like to hear from those who are in a position to try it.

Blue Colour observed in the Scintillation of the Stars.—C. Montigny.—The blue colour is most rarely observed in dry seasons and conversely most abundantly in wet years.—*Les Mondes.*

EXPANSION OF SOLID AND FLUID BODIES.

By HERM. FR. WIEBE.

On page 610, "Annual Report for 1878 of the German Chemical Society" (*Deutsche Chemische Gesellschaft*), I published some short remarks on the expansion-coefficient of solid bodies in its relation to the atomic volume. This relation, formerly unnoticed, is likely to throw some light upon the mechanical causes, still wrapt in such profound darkness, of the expansion of solids and liquids, and to disclose relations of fundamental significance.

(1.) The product of an atomic volume and the cubical expansion-coefficient represents *the absolute expansion of an atom.*

The mere contemplation of the latter already offers for solid elements interesting relations. Iron, cobalt, and nickel are of equal absolute expansion; the absolute expansions of other elements belonging to the same natural group are related to one another, according to simple proportions. Zinc and cadmium, for instance, show a proportion of 2 : 3; arsenic, antimony, and bismuth, 1 : 3 : 4.

Representing the absolute expansions as a function of atomic weight, they seem to present a curve similar to that of atomic volumes. The position of members of the natural families on that curve is an analogous one; maxima give sulphur, selenium, and tellurium, and most probably aluminium, gallium (?), indium, and thallium.

The absolute expansion of atoms manifests itself to be a periodical function of the atomic weight.

(2.) Expansion of a body represents that part of heat necessary to supersede its cohesive power. Suppose—

Density of a body to be	d,
Its atomic weight	a,
Its cubical expansion-coefficient	α,
Its specific heat	c,
Its boiling-point	s,
and Its melting-point	σ,

we have the following relation:—

$$\frac{\frac{d}{\alpha \,.\, a}}{d \,.\, c\,(s-\sigma)} = 2 \quad . \; . \; . \; . \; . \quad (1)^*$$

In words, the inverted value of absolute expansion of an atom stands in the proportion 2 to that quantity of heat necessary to bring equal volumes during constant atmospheric pressure from the melting- to the boiling-point. The equation (1) may still be simplified, when—density solving in the fraction—we have—

$$2\,\alpha \,.\, a \,.\, c \,.\, (s-\sigma) = 1 \quad . \; . \; . \; : \quad (1a)$$

The subjoined table contains a compilation of expansion values of a few bodies in figures. (See next page.)

(3.)† In gaseous substances the molecules are so far separated as no longer to influence one another. Liquid and solid bodies consist of molecular groups, which evidently are formed by those especial powers, emanating from the molecules themselves. At the boiling-point, as well as at that of melting, *all bodies possess an equal degree of cohesion.* Therefore, if we multiply the absolute expansion of an atom with the temperatures of these fixed points (the temperatures having been augmented by the inverted expansion-coefficient previously), the result will be comparable figure-values, *all of which are multiples of the expansion-coefficient.*

For brevity's sake we give in the following table in the column immediately following the elements, the figures representing the absolute expansion of the atom; the second and third columns contain respectively the melting-point on the common scale, and in so-called absolute temperature; the fourth shows the product of the absolute expansion and temperature; and the fifth the expansion-

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* See "Annual Report for 1878 of the German Chemical Society," p. 788.

† The following is an abstract of a paper, which will be published in the next number of the above-mentioned report.

Element.	d	a	α	c	s		$\frac{\frac{d}{a.\alpha}}{c.d\,(s-\sigma)}=2$
S ..	2·04	31·98	0·0002670	0·1710	447	113·6	$\frac{238·9}{116·3}=2·05$
Se ..	4·60	78·00	0·0001696	0·0801	700	217	$\frac{358·5}{177·97}=2·02$
P ..	2·30	30·96	0·0003556	0·1900	278	44·5	$\frac{208·9}{102·4}=2·04$
Hg ..	13·596	199·8	0·0001882	0·0333	355·8	−40	$\frac{361·6}{179·2}=2·02$

coefficient and a constant—characteristic with each matter—expressed by the letter *m*.

Element.	I. Absolute Expansion of the Atom per 1 deg.	II. Melting-point in Common Scale.	III. Melting-point in Absolute Temperature so-called.	IV. Product III. I.	V. Expansion Coefficient.	*m.*
S	0·003015	113·6	388·6	1·171629	0·003905	300
Se	0·001872	217	492	0·921024	0·003607	250
Te	0·001029	489	764	0·786156	0·003931	200
Zn	0·000795	412	687	0·546165	0·003641	150
Cd	0·001188	315	590	0·700920	0·003505	200
As	0·000222	500	775	0·172050	0·003721	50
Sb	0·000630	430	705	0·444150	0·003701	120
Bi	0·000864	264	539	0·465696	0·003725	125
In	0·001911	176	451	0·861861	0·003591	240
Tl	0·001557	290	565	0·879705	0·003665	240
Pl	0·001530	334	609	0·931770	0·003728	250
Fe	0·000255	1600	1875	0·478125	0·003678	130
Co	0·000255	1500	1775	0·452625	0·003621	125
Ni	0·000255	1450	1725	0·439875	0·003665	120

Without at present enlarging upon these constants as to their explanation we simply wish to point out the fact that they seem to be *in relation with the number of atoms, combining to form a solid molecular group; constants show, for elements of the same chemical group, simple proportions.*

To the boiling-point similar proportions are applicable; tho following relation, therefore, is generally adopted:—

$$\frac{a\,.\,\alpha}{d}\,.\,\mathrm{T}=\beta\,.\,m\;.\;.\;.\;.\;.\;.\quad(2)$$

in which β represents the expansion-coefficient in a gaseous matter; T the interval of temperature from the boiling- to the melting-point, or from the latter to the so-called absolute zero-point; and α the medium expansion-coefficient within these intervals of temperature.

It appears that the "Gay-Lussac rule" is generally valid, quantitatively changed only in its application to the fluid and solid state of matter; hence a common law of expansion is applicable to the whole scale of the state of aggregation in matter.

(4.) Applying the equation (2) to homologous rows of organic bodies, proportions astonishingly simple are the result.

The following table contains in column I. the medium absolute expansion of a molecule between melting- and boiling-points, or, the melting-point not being known, between 0° and the boiling-point. The figures of columns II. to V. answer to those in the preceding table.

Substance.	I. Medium Abs. Expansion of the Molecule per 1 deg.	II. Boiling-point in Common Scale.	III. Boiling-point Counted from the Abs. Zero-point so-called.	IV. Product III., I.	V.
Formic acid ..	0·04326	100	375	15·6	5·2 . 3
Acetic acid ..	0·06828	117·3	392·3	26·2	5·2 . 5
Butyric acid ..	0·10235	144	421	46·8	5·2 . 9
Methylic alcohol	0·05000	66·3	341·3	17·06	8·5 . 2
Ethylic alcohol	0·07143	78·3	353·3	25·26	8·5 . 3
Amylic alcohol	0·12500	131·8	406·8	50·8	8·5 . 6

In this manner general formulæ for the boiling-points of both these homologous rows are easily established.

For the acids, the constant 5·2 is to be multiplied with the —by one augmented—number of atoms of hydrogen contained in gaseous molecule; for the row of alcohols, the constant 8·5 with half the number of atoms of hydrogen.

We purpose treating the above subject more *in extenso* very soon, especially to enlarge upon the theoretic significance of the constant *m.*

Berlin, September, 1879.

CORRESPONDENCE.

DISSOCIATION OF CHLORINE.

To the Editor of the Chemical News.

Sir,—Mr. F. P. Dunnington, in his short notice on the "Dissociation of Chlorine, seems to have mistaken $PtCl_4$ for $Pt_2Cl_4(PtCl_2)$, two very different chlorides. If he refer to the quoted article, Chemical News, vol. xl., p. 69, or to p. 49, he will find $PtCl_2$ is the chloride Victor Meyer used. Due care *was* taken to exclude the possibility of oxygen compounds being present, and more, *extraordinary* care was taken. The $PtCl_2(Pt_2Cl_4)$ was amply proved to be chemically pure before use, a point which it can hardly be thought for an instant a chemist of European reputation like Victor Meyer would overlook or neglect. It is very evident that Mr. Dunnington had succeeded better in preparing his own pure chlorine if he had but used this very $PtCl_2(Pt_2Cl_4)$ for the purpose, as Victor Meyer did.—I am, &c.,

Watson Smith, F.C.S., F.I.C.

City of London College.—Evening Classes for Young Men, 52, Leadenhall Street, E.C.—The Prospectus of this Institution has been published, stating that the new Session commences on Monday, October 6th. The Inaugural Address will be given by the Right Rev. the Bishop of Bedford, Bishop Suffragan of London, on Thursday evening, October 9th, at 8 o'clock, the subject being "Books, and how to use them." A glance at the Prospectus shows that the Council of the College are extending its curriculum, the array of classes being greater than in any previous session. The need of a much larger building has been thoroughly proved, and it is hoped that the exertions of the Council to obtain a site for a new college will soon be successful. It surely is not too much to expect that some of the wealthy citizens of this great metropolis, emulating the example set by many in several provincial towns, will come forward with a portion of the fortune which they have amassed, in aid of so worthy an object as the rearing of a fine and commodious building for the express purpose of improving, mentally and morally, the young men on whom these merchant princes depend for the proper conduct of their business. No more philanthropic object can engage their attention.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 8, August 25, 1879.

Digestive Ferment of Carica Papaya.—A. Wurtz and E. Bouchut.—From the undecomposed juice of this tree the authors have obtained by precipitation with alcohol, the ferment, in the form of an amorphous white powder, entirely soluble in water, and containing 10 per cent of nitrogen. To this substance they have provisionally given the name of papäin. It is distinguished from pepsin by the circumstance that it is capable of dissolving large quantities of fibrin not merely in presence of a small quantity of acid, but even in a neutral or slightly alkaline medium. It is doubtless analogous to the ferments secreted by carnivorous plants such as Nepenthes, Drosera, &c.

Reply to the Observations of M. Berthelot.—A. Wurtz.—A continuation of the chloral controversy.

Compressibility of Gases at High Pressures.—E. H. Amagat.—It appears very probable that when a gas submitted to increasing pressures, whether or not it has shown at first an augmentation in its compressibility, presents afterwards a decrease, it is always placed in conditions where it may, by pressure alone, pass gradually through all the intermediate conditions between the gaseous and the liquid state without liquefaction properly so-called. The decrease in the compressibility indicates then in general that the gas has reached a temperature higher than that of the critical point.

Maximum Tension and the Density of the Vapour of Alizarin.—L. Troost.—The maximum tension of the vapour of alizarin is about 11 m.m. at 261°, and 20 m.m. at 276°. The density observed is 16·32 as against 16·62 by calculation.

Purification of Hydrogen.—A. Lionet.—Oxide of copper in the cold arrests all the combinations of hydrogen which may be present as impurities, except the hydrogen carbides.

Active Principle of Ammi Visnaga.—M. Ibrahim Mustapha.—The author has isolated a crystalline matter, which behaves like a glucoside. The composition of this principle, for which the author proposes the name kellin, is not given.

Distribution of Copper in the Primitive Rocks and in their Derived Sedimentary Deposits.—L. Dieulefait.—Copper is disseminated throughout the entire thickness of the primordial formation. In no case is it requisite to operate on more than 100 grms. of rock in order to isolate the metal. It is also found in the ordinary sedimentary deposits, such as the silurian and infra-silurian of Algeria, &c. The last mother-liquors of the salt marshes of the Mediterranean contain copper in such quantity that it may be easily detected in 5 c.c.

No. 9, September 1, 1879.

Note on the Solar Temperatures.—J. Jansen.—The author considers that the nucleus of the sun is much hotter than the photosphere or any of the exterior strata. The expression "solar temperature" is deficient in precision. The calorific and thermo-electric methods generally employed seem capable of a rational use for determining the thermic power of the solar radiation which arrives at the earth's surface, but they cannot give exact notions as to the real temperatures of the sun, not even for its mean temperature, an expression which as applied to the sun seems almost without meaning.

The Chemical Constitution of Alkaline Amalgams.—M. Berthelot—The author considers these amalgams as of great importance as the type of compounds resulting from the union of two solid constituents, such as the metallic alloys, the cryohydrates, the fats, butters, resins, &c. Are these products formed by the simple mixture of certain definite compounds, associated sometimes with each other, sometimes with one of the components in excess, in the manner of two powders mechanically mixed, and then brought into a coherent mass by external pressure? Or are the properties of each of these definite compounds modified more profoundly by the presence of an increasing dose of the other definite compound or by that of the component in excess, so that the properties of the total mass cannot be represented by the pure and simple sum of those of the two definite bodies supposed to be mixed? These questions the author endeavours to solve by thermo-chemical methods.

Partial Synthesis of Milk-sugar, and Contribution to the Synthesis of Cane-sugar.—E. Demole.—The author recognises a profound difference between milk-sugar and cane-sugar. Two mols. dextro-glucose, re-united and with loss of water, will not in any case reconstitute cane-sugar. Milk-sugar, in contact with dilute acids, is resolved into two isomers, galactose and lacto-glucose. These products, freed from acid and carefully evaporated to dryness, were treated with 3 parts of acetic anhydride, yielding a body having all the properties of octacetylated milk-sugar.

Reaction of Tungstates in Presence of Mannite.—M. Klein.—There is a parallelism between the reactions of the biborates and those of the para-tungstates and meta-tungstates, which extends even to the properties of the compounds which these bodies form with mannite,—compounds otherwise devoid of interest.

Determination of Urea; a Reply to M. G. Esbach (*Comptes Rendus*, Aug. 18, 1879).—C. Méhu.—The author states that in presence of pure sugar sodium hypobromite liberates all the nitrogen of the urea and nothing more.

No. 10, September 8, 1879.

Compounds of the Hydracids with Ammonia.—E. J. Maumené.—If crystals of ammonium hydrosulphate reduced to a fine powder are added to very concentrated ammonia, cooled down to 0°, we obtain after the lapse of some hours transparent crystals of the mean composition $HS(H_3N)_2$, that is to say, a very basic hydrosulphate. Theory enables the author to predict the existence of two series of four members each, in one of which the ammonia predominates, and in the other the sulphuretted hydrogen.

Any two compounds, either of one or both of these series may again combine among themselves so that the compounds of HS and H_3N are innumerable. The compounds of hydrochloric acid and ammonia offer analogous relations.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 18, 1879.

Action of the Aldehyds upon Chloral-ammonia.—R. Schiff.—By mixing equivalents of dry chloral-ammonia and benzaldehyd, a compound was obtained of the composition $C_9H_8Cl_3NO$. Valeraldehyd, furfurol, œnanthol, and acetaldehyd exert a similar action.

On Penta-brom-resorcin.—R. Benedikt.—This product, which Liebermann and Dittler have felt it incumbent upon them to re-name tribrom-resoquinon bromide, has been examined as to its behaviour with reducing agents, when tri-brom-resorcin is produced, and with aniline and phenol.

A Hydrocarbon obtained from Rosin Oil by Heating with Sulphur.—W. Kelbe.—If the highest-boiling products of the dry distillation of rosin are heated with sulphur to 200°, a crystalline body is obtained consisting of 91·5 per cent carbon and 8·5 hydrogen.

Derivatives of Oxy-propyl-benzoic Acid.—R. Meyer and J. Rosicki.—An examination of para-diphenyl-benzol and of its further derivatives.

A New Reaction of Kreatinin and Kreatin.—Th. Weyl.—If a few c.c. of recent human urine are mixed in a test-tube with a few drops of a very dilute solution of sodium nitro-prusside, and if dilute soda-lye is then added drop by drop, a beautiful ruby-red colour appears, which in a few minutes changes to an intense straw-yellow. This reaction seems characteristic of kreatinin. As kreatin is converted into kreatinin by boiling with dilute sulphuric acid, the reaction may serve also for the detection of this substance.

Aceto-propionic Acid, and its Identity with Levulinic Acid.—Max Conrad.—The melting-points, boiling-points, specific gravities, indices of refraction, and powers of dispersion of the two acids are identical.

A Correction.—P. Griess.—The author points out an error in the formula of amido-benzoic-percyanide as given in his paper (*Berichte*, xi., 1985).

Preliminary Communication.—G. Vortmann.—This notice relates to the cobalt-ammonia compounds.

Perchloro-phenol-chloride.—F. Beilstein.—This substance was repeatedly formed on passing chloride into an acetic solution of the acetyl compound of meta-chloranilin.

Accuracy of Themo-chemical Numerical Results.—Julius Thomsen.—The author replies to M. Berthelot by pointing out a number of inaccuracies in the results published by the latter.

Action of Hypochlorous Acid upon Ethylen.—L. Pebal.—A preliminary communication, in which the author's own results do not appear.

Aspido Spermin, an Alkaloid of the Quebracho Bark.—G. Fraude.—Aspido spermin crystallises in small white prisms with strongly shining surfaces, readily soluble in alcohol and ether, but dissolving sparingly in water, and melting at 205° to 206°. The taste of the solutions resembles that of quinine.

New Investigations on the Diazo-compounds.—P. Griess (Part vi.).—In this valuable paper, which unfortunately does not admit of abstraction, the author examines the action of certain sulpho-diazo-acids upon the phenols.

New Glucoside from Lupinus luteus.—E. Schulze and J. Barbieri.—The substance obtained is lupinin, which is readily split up into lupigenin and a glucose, probably dextrose.

Transformation of Acetaldehyd into Mercaptan.—C. Böttinger.—Not adapted for abstraction.

Hydrazin Compounds of the Fatty Series.—E. Fischer.—The author describes the preparation of diethyl-hydrazin, its oxidation, and its behaviour with nitrous acid.

Contributions to the Voluminar and Steric Laws.—H. Schröder.—In this memoir the author applies his theory to the compounds of thallium and ammonium.

Dimethyl-acrylic Acid.—W. von Miller.—The author obtains this acid by distilling with sulphuric acid an oxidation product arising from the action of permanganate upon isobutyl-formic acid.

Actions of Nitrosyl Silver.—W. Zorn.—An examination of the behaviour of nitrosyl silver with ammonium chloride, with methylamin and aniline hydrochlorates, phenol and acetester.

Transformation of Undecylenic Acid into Undecylic Acid.—F. Kraft.—Not suitable for abstraction.

Absorptive Power of Arable Earth, and of Silicic Acid.—J. M. v. Bemmelen.—In opposition to Liebig, the author refers this absorption not to physical surface attraction, but to chemical action.

On Propyl-benzoic Acid.—E. Paterno.—The author points out that propyl-benzoic acid, described as new by H. Korner (*Berichte*, p. 1863), was described by Spica and himself in June, 1877.

Action of Chloro-carbonic Ethylether upon certain Oxygenated Haloid Compounds of the Fatty Series.—O. J. Kelly.—The author examines the behaviour of chloro-carbonic ethylether with dibrom-allylic alcohol, with dichlorhydrin, and epichlorhydrin.

Contribution to the Knowledge of Alstonia Bark.—O. Hesse.—The alstonin of palm is a mixture of chlorogenin and porphyrin, and the alstonin of F. v. Müller and Rummel an impure chlorogenin.

The Initial Members of the Paraffin Series on Exhaustive Bromation.—V. Merz and W. Weith.

The Final Products of the Exhaustive Bromation of certain Paraffins having Higher Molecules.—V. Merz and W. Weith.—Methan at 180° is converted by direct bromation into perbrom methan. Carbon sulphide, under the influence of iodiferous bromine, undergoes this metamorphosis, partially at least at common temperatures. On heating perbrom-methan the immediate product is perbrom-ethylen, and at 350° perbrom-benzol. Ethan, ethyl iodide, and ethylen dibromide, in contact with iodiferous bromine, are converted into perbromised ethylen and ethan at 200° to 250°. The hydrocarbons of the fatty series behave on energetic bromation exactly as they do on energetic chloration, save that bromine reacts less readily than chlorine.

Process for the Determination of Vapour-densities of Bodies boiling above 440°, as also of such Bodies as act upon Mercury and Wood's Metal.—V. Meyer and C. Meyer.

On Substituted Phthalinites.—S. Gabriel.—A description of chlorphenyl-phthalimid, of brom- and iod-phenyl-phthalimid, of nitro-phenyl-phthalimid, and of ortho- and meta-phthalimido-benzoic acid.

Certain Derivatives of Ortho-nitro-phenol.—Jos. Bendix.—The author attempting to produce dioxy-diphenyl-sulphurea, obtained instead oxy-phenyl-sulphurea.

On Orthotheoformic Benzyl-ether.—M. Dennstedt.—The author has obtained and analysed this body, which has the composition $C_{22}H_{22}S_3$.

Action of Sulphuric Anhydride upon Pseudo-sulpho-cyanate of Phenyl.—G. Magatti.—Noticed under *Gazzetta Chimica Italiana.*

Synthesis of Oxyketons by the Introduction of Acid Radicles into Phenols.—O. Doebner and W. Stackmann.—In this communication the authors describe the formation of oxyketons by the action of benzoyl chloride upon resorcin.

On Malachite Green.—O. Doebner.—A controversial paper directed against E. and O. Fischer. The author maintains that the composition of malachite green is $C_{23}H_{24}N_2$; that its reduction-product, $C_{23}H_{26}N_2$, is identical with the base obtained from the oil of bitter almonds; and that the green colouring-matters formed on the oxidation of this base are not proved to be identical with malachite green.

Methylated Anilines and Toluydins, and their Coloured Derivatives.—P. Monnet, F. Reverdin, and E. Noelting.—Noticed elsewhere.

Les Mondes, Revue Hebdomadaire des Sciences.

No. 16, August 14, 1879.

Prof. Sonnenschein has given the somewhat singular name of "Virginia" to a substance which he has extracted from the residues of the distillation of petroleum. He describes it as a semi-transparent mass, yellowish, and fatty, and displaying, when heated, a blue fluorescence. It melts at 47°, and is partially soluble in ether.

No. 17, August 21, 1879.

The French Association for the Advancement of Science has held its annual meeting at Montpellier from Aug. 24 to Sept. 4, under the presidency of M. Bardoux. Public lectures have been delivered on the Rhone irrigation canal and on the electric light.

In noticing the proceedings of the International Office of Weights and Measures, M. Moigno suggests that it would be preferable to adopt as the true unit of measure the cubit of the great Pyramid, the same as the inspired cubit of Moses and Solomon, the ten-millionth part of the polar axis of the globe. He proposes that the meridian of the pyramid should be adopted by all nations as the first meridian.

M. l'Abbé le Dantec has constructed an electric machine which doubles the force of the Carré machine. He obtains from it continuous sparks of 15 centimetres.

Les Mondes will be carried on for the future by a limited liability company, the editorship remaining unchanged.

No. 18, August 28, 1879.

A New "Splendeur de la Foi."—M. Moigno proposes an exploring expedition to the Red Sea and the isthmus of Suez for the purpose of discovering relics of the army of Pharaoh. A branch-expedition is to seek for the aërolites which fell from heaven in the famous battle gained by Joshua, and which covered the soil about Bethoron. M. Moigno suggests that the sale of these stones would to a large extent cover the expense of the expedition. He takes occasion to misconstrue the language used by Prof. Richard Owen concerning the isthmus of Suez at the Congress of Orientalists, held in London in September, 1874, accusing him of making the Red Sea disappear from the region traversed by the Israelites.

No. 1, September 4, 1879.

This issue contains no original matter in physics or chemistry. Two articles are devoted to attacks upon Prof. Paul Bert, in the latter of which the editor states that he for the *first time* inserts a paper on religious polemics!

No. 2, September 11, 1879.

This issue again contains no original chemical or physical matter. There is an article on the *Splendeurs de la Foi*, and a very violent attack upon the French Government for wishing to keep in its own hands the right of granting Academical degrees.

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THE CHEMICAL NEWS.

Vol. XL. No. 1036.

NOTE ON THE
BEHAVIOUR OF DOUBLE CHLORIDE OF COPPER AND AMMONIUM WITH FERROUS SULPHIDE.

By W. F. K. STOCK, F.C.S., F.I.C.

Whilst experimenting recently on the accurate determination of carbon in iron or steel containing much sulphur, it appeared to be desirable to ascertain definitely in what manner the reagent used for the carbon separation operated upon the iron-sulphur compound, but as the actual composition of that compound could only be speculated upon in the vaguest light, if at all, it was thought best to work upon a sulphide of known quality, and afterwards, if the preliminary experiment showed it to be feasible, to endeavour to separate and examine the unknown sulphide.

The process used for the carbon separation was that known as McCreath's method, and consisted in treating a weighed quantity of iron or steel with a hot concentrated solution of double chloride of copper and ammonium ($2NH_4Cl,CuCl_2,2H_2O$), the reaction depending upon the simultaneous formation of ferrous and cuprous chlorides, the carbon being left in a free state.

A tolerably pure ferrous sulphide was prepared by heating a bar of good wrought-iron to whiteness in a coke fire, and plunging it into a Cornish pot containing melted sulphur, and when the greater part of the sulphur was used up the pot was closely covered and heated to bright redness, the excess of sulphur being thus got rid of.

A careful analysis of the pounded and mixed sulphide gave the following figures:—

Iron..	63·98 per cent
Sulphur	33·86 ,,
Sand, &c.	2·16 ,,
	100·00 ,,

Theory requires for FeS—

Iron..	63·63 per cent
Sulphur	36·37 ,,
	100·00 ,,

It will be seen that in the prepared sulphide the iron is very slightly in excess of the sulphur.

On treating 0·5 grm. of the powdered sulphide with 50 c.c. of the concentrated copper-ammonium solution at nearly boiling heat for half an hour, the original blackish grey colour of the sulphide was changed to yellowish grey, and upon filtering off the residue, washing first with boiling water, next with strong alcohol, and finally exhausting with carbonic disulphide, a great part of the residue was found to have been dissolved by the latter menstruum, which, upon spontaneous evaporation, yielded a crop of micro-crystals, and these under a one-inch objective, and viewed with binocular vision, afforded some exquisitely perfect rhombo-octahedra.

It thus became evident that the action of the double copper-ammonium salt upon iron-carbide and iron-sulphide was precisely analogous, and that the method held out no hope of separation. It only remained to find to what extent the decomposition had proceeded during the half hour's exposure, and this was effected by igniting the residue, after treatment with carbonic disulphide, in a muffle with free access of air, and weighing as Fe_2O_3. 0·5 grm. sulphide gave 0·0954 residual Fe_2O_3, which is equal to 19·09 per cent undecomposed sulphide. Hence, allowing for oxidation during washing, &c., it may safely be assumed that 80 per cent of the original sulphide was decomposed by the double copper-ammonium salt, with a proportional liberation of free sulphur.

A second experiment was made with native ferric sulphide, which was very finely powdered and exposed at boiling heat for over an hour to the copper solution as before, but, although some free sulphur was obtained, the decomposition was far from complete.

ON SCANDIUM.

By M. P. CLÈVE.

In the sitting of March 24, 1879, M. Nilson announced the discovery of a new element, which he named scandium, and which he had extracted from ytterbia. Some weeks after this publication I found the same metal in the gadolinite and yttrotitanite of Norway, and have examined its characters.

It occurs in minute quantities only. Gadolinite contains 0·002 per cent of the oxide, and yttrotitanite 0·005. Its only oxide, scandia, has the formula Sc_2O_3. The composition of the double ammoniacal sulphate and the double potassic oxalate proves the correctness of this formula. The atomic weight of scandium = 45·12. Scandium oxide, or scandia (Sc_2O_3), is a perfectly white, light, infusible powder resembling magnesia. Even the strongest acids attack it with difficulty, yet it is more soluble in acids than is alumina. Sulphuric acid yields with scandia sulphate as a white voluminous mass resembling thorium sulphate in appearance. Scandia dissolves more readily in hydrochloric than in nitric acid. The specific gravity of the oxide is approximately 3·8. The hydrate is a white bulky precipitate, resembling hydrate of alumina. If dried it forms semitransparent fragments. It does not appear to absorb the carbonic acid of the air. It is insoluble in an excess of ammonia or of caustic potassa. It does not decompose sal-ammoniac if heated together.

The salts of scandium are colourless or white; they possess a very harsh, astringent taste, quite distinct from the sugary flavour of the other yttria earths. The sulphate does not form distinct crystals; the nitrate, formiate, oxalate, and acetate are crystallisable. The chloride gives the following reactions:—If heated in the gas-flame it does not produce a spectrum. Potassa and ammonia give a voluminous precipitate, insoluble in excess of the reagents. Tartaric acid prevents precipitation in the cold, but if the solution is heated an abundant and voluminous precipitate appears. Sodium carbonate produces a voluminous precipitate, soluble in excess. Sulphuretted hydrogen effects no change. Ammonium sulphide precipitates the hydrate. Sodium phosphate gives a gelatinous precipitate. Oxalic acid produces a curdy precipitate, which is speedily transformed into a crystalline powder. The oxalate is soluble in concentrated acids, and its separation from an acid solution is not complete. Although the oxalate appears more soluble than the oxalates of the other earths it is found in the first fractions when a mixture of salts of scandium and ytterbium is submitted to partial precipitation. The acid oxalate of potassa gives a double salt in a crystalline powder. Sodium hyposulphite precipitates a boiling solution readily, but not completely. Sodium acetate gives a precipitate at the boiling-point, which is readily detached from the filter, but the precipitation is incomplete. In concentrated solutions potassium sulphate occasions the separation of a double salt as a crystalline powder, soluble in a saturated solution of potassium salt. Sodium sulphate behaves in the same manner. The author has described in his memoir the chloride, nitrate, sulphate, three double sulphates, a double oxalate, the selenite, acetate, and formiate. The great interest of scandium is that its existence had been predicted. Mendeleef, in his memoir on the law of periodicity, had foreseen the existence of a metal which he named ekabor, and whose characters agree very fairly with those of scandium.

Predicted Characters of Ekabor.	*Observed Characters of Scandium.*
Atomic weight = 44.	Atomic weight = 45.
Ekabor should have only one stable oxide, Eb_2O_3, a base more energetic than alumina, with which it has several characters in common. It should be less basic than magnesia.	Scandium has only one oxide, Sc_2O_3, a base much more energetic than alumina, but feebler than magnesia.
Though yttria should be a more energetic base we may foresee a great resemblance between yttria and oxide of ekabor. If ekabor is found mixed with yttrium their separation will be difficult and will be founded on differences of solubility and of basic energy.	Scandia is less basic than yttria, and their separation depends on the different stability of their nitrates on exposure to heat.
Oxide of ekabor is insoluble in alkalies; it is doubtful if it will decompose ammonium chloride.	Hydrate of scandium is insoluble in alkalies and does not decompose ammonium chloride.
Its salts will be colourless and give gelatinous precipitates with KOH, Na_2CO_3, and HNa_2SO_4.	Salts of scandium are colourless and give gelatinous precipitates with KOH, Na_2CO_3, and HNa_2SO_4.
With potassium sulphate it will form a double salt having the composition of alum, but scarcely isomorphous with that salt.	The double sulphate of ammonium and scandium is anhydrous, but has in other respects the composition of alum.
Few of the salts of ekabor will crystallise well.	Scandium sulphate does not form distinct crystals though the nitrate, acetate, and formiate are crystalline.
Water will decompose the anhydrous chloride of ekabor with liberation of hydrochloric acid.	The crystalline chloride is decomposed and evolves hydrochloric acid when heated.
The oxide will be infusible, and after ignition will dissolve in acids with difficulty.	The ignited oxide is an infusible powder and dissolves in acids with difficulty.
The specific gravity of the oxide will be about 3·5.	The specific gravity of the oxide is 3·8.

—*Comptes Rendus.*

ON THE

SEPARATION OF PHOSPHORUS AND IRON, ESPECIALLY WITH REFERENCE TO THE MANUFACTURE OF STEEL.*

By THOMAS BLAIR.

(Concluded from page 152.)

Krupp's Process for Dephosphorising Pig-Iron.—Professor Wedding gives some data on the practical working of Krupp's, or rather Narjes', process for dephosphorising pig-iron. "The originator of the process is Mr. Narjes, an engineer connected with Herr Krupp's works at Essen, who, on the 16th and 17th March, 1877, worked the first heat on a large scale, 4 tons of pig, holding 0·7 per cent. of phosphorus, being reduced to metal running 0·134 per cent., while the percentage of carbon sunk only from 3·1 to 3·03 per cent. Narjes' process consists in dephosphorising and refining the pig, without affecting the carbon percentage materially, by oxides of iron and manganese, partly used as fettling and partly as additions. The practice at Essen is said to be simple; the pig is melted in a 13-foot cupola with coke in one hour and a half, and is then tapped into a furnace similar to the Pernot, heated by the regenerative system. The flat hearth is covered with a layer of almost one foot of iron ore melted on at a very high temperature. Before every heat from 1500 to 1700 pounds of ore, also heated until sintered, are added before the iron is tapped from the cupola. The temperature during the operation of dephosphorising is a strong white heat, which constitutes the difference between the Krupp and the Bell methods. At first the furnace is made to revolve twice in a minute, which is soon increased to five. Generally after five, and never after more than ten minutes, the dephosphorisation and refining are completed—a point which is indicated by the commencement of bubbling and the appearance of small flames of carbonic oxide. The following analyses, made by Professor Tinkener, of the Berlin School of Mines, will show that dephosphorisation is effected without any diminution of the percentage of carbon, '*a*' designating before and '*b*' after the process:—

	I *a.*	I *b.*	II *a.*	II *b.*	III *a.*	III *b.*
" Carbon	3·39	3·75	3·81	3·56	3·17	3·02
	3·98	3·77	3·78	3.57	3·16	3·04
" Phosphorus	0·632	0·131	0·45	0·108	1·223	0·303
	0·629	0·133	0·445	0·106	1·218	0·301

"All the analyses, it will be seen, were made in duplicate. It is expected, although it has not yet been proved experimentally, that manganiferous pig will work more favourably still. Another point which has not yet been settled is whether it will be possible, by adding a silicious pig, to fit the refined metal for the Bessemer process, for which, as at present constituted, it is not suitable, as the *dephosphorising process eliminates the silicon simultaneously.*"

Dr. J. M. Brown pointed out recently that phosphorus and silicon were largely removed, and carbon completely, by heating with sodium or other alkaline carbonates in a platinum vessel.

Herr Krupp, of Essen, is said to have forced through a bath of molten iron streams of fused alkaline chlorides, fluorides, &c., and with some measure of success.

The late Mr. William Baker, of this town, found that a distinct quantity of phosphorus was removed by blowing chlorine through molten iron in a plumbago crucible, but that in an ordinary fire-clay crucible the action was but slight. He attributed some of the success of this experiment to the presence of an excess of carbon.

Almost every salt known to chemists has been tried from time to time, but most frequently by people who could give no reason for their suggestions. The preceding may, perhaps, be taken as the most noteworthy processes possessed of any reasonable symptoms of practical success which were known up to the present, with the single exception of Mr. Snelus's experiment in 1872.

Mr. G. J. Snelus in that year found that phosphorus could be eliminated in the Bessemer converter by forming a basic slag, and he effected this by lining the vessel with basic material, in contrast to the usual gannister or acid lining. Silica being a more powerful acid than phosphoric displaces the latter from combination at high temperatures; consequently, unless the silica is thoroughly saturated, there can be no free base for the phosphoric acid to combine with, and therefore, in contact with iron at high temperatures, it will be reduced as fast as made, if, indeed,

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* Read before the British Association for the Advancement of Science Section B.), Sheffield, 1879.

the phosphorus is oxidised at all under these conditions. These considerations led Mr. Snelus to believe that phosphorus was removed in all processes, just in proportion to *the basic nature of the slag*.

Observing that certain kinds of limestone, the magnesian variety especially, when submitted to very intense heat, became indurated, and converted into a form in which they were no longer acted on by water, Mr. Snelus lined up a 2 cwt. converter with lime made from this stone, and fired off at a very high temperature. By keeping the slag basic he successfully dephosphorised Cleveland pig-iron. His results were eminently satisfactory, proving beyond a doubt that he had hit upon the proper method. Unfortunately, Mr. Snelus allowed his process to lie dormant, and was thus shorn of the glory which would otherwise have been his. His statement made at the Iron and Steel Institute in May this year was conclusive though tardy.

Messrs. Thomas and Gilchrist have, with great energy and perseverance, been able to succeed chemically in producing good steel from Cleveland pig. Their first experiments were made at Blaenavon, in South Wales, and their results there were sufficiently satisfactory to induce practical steel-makers to take up the subject. Mr. E. Windsor Richards, of Messrs. Bolckow, Vaughan, and Co.'s works, Middlesborough, went into the matter so thoroughly that steel rails have already been made in considerable quantities by this process.

Briefly, the process of Messrs. Thomas and Gilchrist consists of the following points :—

1. A durable basic lining.
2. The addition of basic materials.
3. Removal of phosphorus by blowing after the carbon has been eliminated.

In the first place immense difficulties have been experienced in producing a durable basic lining. Caustic lime, as is well known, is not stable under ordinary atmospheric conditions. But, as has already been pointed out, Mr. Snelus was able to select certain kinds of magnesian limestone which became indurated by calcination at very high temperatures. Linings have thus been made, which seem tolerably permanent. A brick and some pieces are on the table, and have the following composition :—

Silica	9·2	per cent.
Lime	46·7	„
Magnesia	32·8	„
Oxide of iron, alumina, alkalies, &c.	11·7	„

It will thus be seen that a very successful result has been arrived at, as this brick is extremely hard and appears durable in the air, since it has been kept for some months without protection.

The method recently adopted was simply to form the mould as usual with such a mixture of the various seams of the magnesian limestone as would give a composition similar to the analysis given; to dry the brick gently; fire it in a kiln—first, moderately; then at a most intense white heat, so intense, indeed, that ordinary silica bricks are melted. Silicate of soda has also been used as a binding material.

Mr. Riley has found that quick-lime may be rendered plastic by admixture with petroleum or kindred oils, and either moulded into bricks or rammed in the vessel as is done with ordinary gannister.

The writer is informed that, in practice, linings made by either of these processes, when using irons not containing an excess of silicon, answer extremely well.

To prevent the oxidised silicon from attacking the lime lining, additions of lime (with or without admixture with oxide of iron) are made. This proceeding is a very wise one, and is found to answer well. Similarly in the reverse case, in the Hollway metallic sulphides process, in which large quantities of ferrous oxide are formed by oxidation, in a gannister or silicious-lined vessel, additions of powdered gannister are found to be very effective in mitigating the corrosive action of the oxide on the lining. Samples of the various materials used for refractory linings are shown.

2nd. The vessel being lined with the basic bricks and ready for use, about 6 tons of Cleveland pig-iron are poured in, and with or before this a quantity of about a ton of the basic material. This same vessel would take 8 tons of ordinary hæmatite Bessemer pig. The blow then commences, and differs but little from the ordinary Bessemer blow until the carbon is burnt out.

3rd. At this moment the vessel is turned down, and a sample is taken which is rapidly hammered out and broken, and from the appearance of the fracture and its brittleness a rough estimate is formed of the amount of phosphorus remaining. The vessel is then turned up, and the charge is blown for about thirty seconds, and a second sample is taken and examined as before. This operation is repeated, with diminishing times, until a sample is obtained which shows a small fine grain, and is sound on the edges. From 8½ to 10 per cent of spiegeleisen is then added, as in the ordinary process, but in this case a somewhat violent reaction takes place between the metal and spiegel, owing most probably to the fact that some amount of oxide of iron is formed, which is rapidly attacked by metallic manganese. The metal is then poured into the moulds as usual, and sent to the mills.

The following are analyses of a blow by this process :—

	Pig-iron.	1st Samp.	2nd Samp.	3rd Samp.	Steel.
Graphite	2·74	—	—	—	—
Com. carbon	0·30	trace	trace	trace	0.150
Silicon	2·28	trace	—	—	0·018
Sulphur	0·07	0·074	0·068	0·063	0·060
Phosphorus	1·48	0·904	0·238	0·076	0·177
Manganese	0·64	0·070	0·070	0·050	0·500

It will be here noted that the silicon disappears rapidly, and that in three minutes the carbon begins to go also, and that but little of the phosphorus is oxidised until most of the carbon has gone, and all the silicon.

In the refinery, puddling, and Bell's processes, however, the phosphorus commences to leave the iron before all the silicon has gone, and the carbon goes at a comparatively slow rate. This difference may be accounted for by the very much lower temperature of these processes, and the presence of much oxide of iron. But it has been asserted by M. Pourcel, whose opinion is worthy of the highest respect, "that in the old refinery process the phosphorus disappears in direct proportion with the silicon. Thus, when a pig rich in silicon and phosphorus is refined, the phosphorus continues to pass into the slag as long as the silicon is burning, that is to say, as long as the carbon does not burn, and no carbonic oxide is formed by intermolecular action. If the content of silicon is high with respect to the phosphorus and carbon; if the medium in which the process is conducted furnishes no free silica, but, on the contrary, an excess of oxide of iron to neutralise the silica coming from the silicon in the pig, we succeed in scorifying the greater part of the phosphorus."

In the Krupp and Bell processes the period of dephosphorisation is determined by the first appearance of the blue flames of carbonic oxide, showing that the silicon is all oxidised, and that the carbon commences to burn. No further removal of phosphorus takes place, but inasmuch as a reducing action has succeeded to an oxidising one, the phosphorus returns to the iron.

M. Pourcel concludes from this that a highly silicious iron would be advantageous for use in the Thomas and Gilchrist process, but the writer would submit that he is judging from a wrong standpoint, inasmuch as that the carbon in this case is rapidly disappearing at the same time as the phosphorus, and that it is necessary to continue the blow after the carbon has gone solely to scorify the phosphide of iron.

So far, however, from the presence of silicon being an advantage, the reverse is the case, since it not only prolongs the blow, but the silica formed by its oxidation exercises a corrosive action on the lime lining of the converter. Its only advantage is, that it generates a great amount of heat very rapidly during its combustion. Were it possible to obtain the same heat from other sources, it would be possible and profitable to use iron very low in silicon or as free as possible from it.

Various methods have been proposed to effect this, such as, for instance, the substitution of manganese and the addition of carbon, in some form, to the molten metal. Mr. Lowthian Bell, some time ago, proposed to blow in powdered charcoal with the blast. Mr. Hollway proposed to form a neutral gas by blowing air through incandescent coke, and then to introduce with this gas carbon or liquid hydrocarbon. Mr. Wilkes, of Manchester, has made some very promising experiments by simply running petroleum spirit into the ordinary blast pipes.

Mr. Hollway has also patented, for the purpose of raising the heat in the Bessemer converter, a very ingenious modification of the present system. As is well known, a huge flame of carbonic oxide issues from the mouth of the converter, constituting a great loss of heat, as, with but one exception, no attempt has been made to utilise the heat of this flame; but he proposes, by means of a set of upper tuyeres, to burn this carbonic oxide inside the vessel itself. If he succeeds in perfecting such an apparatus, an enormous heat could be maintained, and the use of silicious pigs would cease to be indispensable.

One interesting point deserves notice. Almost invariably, on adding spiegel to the dephosphorised metal, a portion of the phosphorus returns to combination, which must come from the slag, since spiegel contains only minute quantities of that element. Mr. Stead found, some time ago, that spiegel took up phosphorus from slags of this class; that is to say, that manganese reduces free phosphoric acid. To obviate this, it would appear that some modification in the shape of the vessel is desirable to permit of tapping off as much slag as possible.

It is, perhaps, advisable to deal now with the objections which have been raised as to the commercial possibility of this process. They may be briefly summarised as follows:—

1st. Will any and every kind of pig-iron be available?

Every possible kind of pig-iron is capable of treatment by this process; but irons very high in silicon are objectionable on account of the extra quantity of basic additions necessary, the increased quantity of slag, and the extra waste and corrosion.

2nd. That whereas the experimental 35 cwt. vessels have answered the purpose, that the operations in the 8-ton vessels may not succeed.

The fact is, that the probabilities of success are just the reverse, since it is far more difficult to retain the fluidity of a small mass than that of a large one, as the sources of heat loss, conduction and radiation, diminish in direct proportion to the mass, or, to use a technical term, the "body of heat" is greater in the larger mass. In actual practice it has been found that the operations in the large converters are, in this respect, quite as satisfactory as those in the experimental vessels.

3rd. That the waste is greatly increased by blowing after the carbon has gone. Mr. Richards stated in London that the waste in the experimental plant was about 17 per cent. Mr. Gilchrist assures the writer that, on a large scale, it is 17 to 18 per cent. As the waste in the ordinary process is about 15 per cent, it is obvious that no very serious difficulty arises from this cause. The amount of slag formed is from 3½ to 5 cwts. per ton of pig-iron used, as against 1½ to 2½ cwts. in the ordinary process.

At the May meeting of the Iron and Steel Institute it was pointed out by the writer, whose opinion was endorsed by Messrs. Stead, Gilchrist, Thomas, and Richards, that "overblowing" (which means oxidation of iron) only commences when all other oxidisable material has been eliminated. The action of the atmosphereric oxygen only commences on the iron when there is nothing else to oxidise. In fact, Bessemer steel-makers seem to forget that the very essence of this process is that there is another element to burn out. Their experience has taught them that when the "flame drops," or, in other words, when the carbon spectrum disappears, that the blow is over, but in the Thomas and Gilchrist process the blow only ends when the phosphorus has gone.

4th. That the corrosive action on the basic lining is greater than that on the ordinary gannister-lining, and that while the latter admits of repairs, the former does not.

In reply to this it may be advanced that the basic lining has been repaired, and that Mr. Gilchrist quite recently informed the writer that when using iron not containing excessive silicon that no serious amount of corrosion takes place.

5th. That the result of the process in eliminating phosphorus is uncertain.

In the ordinary process, the disturbing element being absent, there is no danger from this cause, but in this process accidents may occur where the quantity left in the steel may cause difficulty. But in regular working there is very little risk. The following analyses of consecutive blows, kindly supplied by Mr. Gilchrist, show this quite conclusively.

In ten consecutive blows, the samples taken from the converter just before adding spiegel contained—

	Phosphorus.
1.	0·10 per cent.
2.	0·05 ,,
3.	0·05 ,,
4.	0·07 ,,
5.	0·07 ,,
6.	0·06 ,,
7.	0·14 ,,
8.	0·04 ,,
9.	0·07 ,,
10.	0·10 ,,

In all cases the pig-iron contained 1·5 per cent of phosphorus. The following are some analyses of steel from the same:—

Phosphorus.	Carbon.
0·11	0·36
0·09	0·21
0·05	0·20
0·08	0·15
0·05	0·08
0·05	0·22
0·04	0·28
0·12	0·40
0·10	0·22
0·07	0·20

Later still, Mr. Gilchrist writes that the last sixteen consecutive blows gave an average of 0·067 per cent P. The C can also be kept at anything from 0·02 to 0·5 per cent, and waste of Mn avoided.

The pieces of steel exhibited were from the Eston Works, and were made by this process. This steel is of excellent quality, though soft. Its analysis is the first of the following; the remaining are analyses of other samples by Messrs. Pattinson and Stead:—

	Rail.	29.	30.	31.	32.
Iron	98·944	98·212	98·724	98·743	98·915
Carbon ..	0·350	0·440	0·363	0·385	0·320
*Silicon ..	0·014	nil	nil	nil	nil
Sulphur ..	0·020	0·115	0·093	0·044	0·110
Phosphorus	0·062	0·085	0·080	0·058	0·058
Manganese	0·610	1·123	0·720	0·750	0·572
Copper ..	—	0·025	0·020	0·020	0·025
	100·000	100·00	100·00	100·00	100·00

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* The absence of silicon is a point worthy of note All analyses of steel made by this process show the same result; for most purposes this fact is decidedly in favour of such steel.

The removal of the phosphorus is not, however, always so complete. M. Pourcel, of Terrenoire, quotes the following analysis of a steel made in his presence :—

	Pig-iron.	Steel.
Carbon	3·20	0·171
Silicon	3·03	traces
Sulphur	0·03	0·037
Phosphorus	1·80	0·223
Manganese	0·45	0·160

Such a steel as this, although adapted for certain purposes, would not, like the preceding samples, be suitable for best purposes.

6th. The cost of the process.

Sufficient experience has not yet been obtained, but seeing that there is a difference of 10s. or 12s. per ton between the cost of hæmatite and common (*i.e.*, phosphoretic) pig-irons, there is a wide margin to work upon, even in these times of abnormally low prices. The costs may be summed up in the following items :—

(1.) The slightly increased waste.
(2.) The extra quantity of slag: the cost of this item mainly consisting in the labour necessary for dealing with it.
(3.) The cost of the basic additions.
(4.) The increase in cost of the linings.
(5.) The decreased productive power of the plant, owing to the facts that smaller charges must be blown, owing to the extra slag formed and risk of splashing, and also the time occupied in taking and examining samples.
(6.) The smaller production of the blast-furnaces in smelting poor phosphoretic ores as compared with the output of those smelting richer non-phosphoretic hæmatites. But this, the writer contends, is already considered in the price of both pig-irons, and is consequently *nil*.

Taking these objections as a whole, it does not appear that they will amount to anything like 10s. per ton, but possibly 7s. 6d.

As a set-off against these may be considered the utilisation of the large deposits of phosphoretic ores in this and other countries, which may be so much more cheaply worked and delivered to the works than hæmatite ores from distant countries, and the prolongation of the lease of life of inland iron-producing districts in all countries which have their own coal and ironstone. As also the fact, from this latter cause, many existing plants will be as favourably situated as new works built on the coast at a distance from coal-fields, as but few coal-fields of any magnitude are within very easy access of seaports.

There is, however, one objection which may be well left till last, as the weakest of all, and that is, that steel made from such raw materials cannot possibly be so good as that made from pure material. Such an exception has been seriously made.

This objection may be well left to answer itself, since every one must admit that two steels of similar chemical composition, and answering to the same tests, are just as good as one another, even if one is made in a crucible from best Swedish iron and the other in a Bessemer converter from phosphoretic iron. It does not require a spirit of phophecy to justify one in predicting that the day is not far distant when steel made either by the Bessemer or open-hearth process will supersede that made by any other process, and of any quality, however fine it may be.

It may be readily admitted that the Thomas and Gilchrist process has not yet entirely surmounted all its initial difficulties; in fact it would be too sanguine to expect that it could do so in so short a time. It is very probable that no single one of the processes alluded to may be the successful one, but that a combination of several of them may bring about the desired result. Be that as it may, it is obvious that this great problem is solved, and that nothing more is wanting than the rapid and effectual removal of the minor difficulties.

LEAD FUME, WITH A DESCRIPTION OF A NEW PROCESS OF FUME CONDENSING.*

By A. FRENCH.

This paper describes a series of experiments made by the author and Messrs. H. J. Wilson and J. Wycliffe Wilson, of the Sheffield Smelting Company, with a view to discover a good process for condensing fumes of lead, silver, and other metals which volatilise in the smelting and refining operations. The loss of lead and frequently of silver by sublimation is an evil with which every smelter is familiar; not only does the loss amount to hundreds of tons of lead in a year at many works, but the injury which is done to health and vegetation is very great. It also describes a new and very successful method of condensing, whereby from 95 to 98 per cent of the metallic contents of the smoke is saved.

The various methods of condensing fumes which have been tried in this and other countries may be classed as follows :—

(*a*.) Deposition of the fume by its own gravity in long flues with or without the addition of a series of settling chambers, placed either near to or at some distance from the furnace.
(*b*.) Filtering through flues, towers, or chambers containing brushwood, coke, coarsely woven fabric, or similar porous material, using water either in a constant or intermittent stream to keep the filters from becoming choked.
(*c*.) The use of water, either in the form of steam, or in showers of drops or jets, projected with some considerable degree of force into and across the current of smoke.
(*d*.) Processes based on the inverse of the preceding principle, viz., passing the smoke under and through a depth of water, either in great volumes as in the old Stagg's condenser, or in a more or less comminuted condition.

Our first step was to ascertain the physical nature o the lead fumes and their deportment under varying conditions of temperature and friction. We exposed slips of glass to the fumes for a second or two so as to obtain a very thin deposit on the glass and examined these by a microscope. The first specimen was taken while the lead was in the true state of a gas by holding the glass slip within the flame of burning lead. This when examined by a high magnifying power, presented the appearance of a uniform grey coating, which was perfectly continuous and without any granular structure. A second one taken while dense white smoke was issuing from the tymp of the furnace had the same grey film, but in addition it had what appeared to be a superposed layer of small rounded particles or rather spheroids having a considerable degree of oblateness. The sizes of these were very uniform in specimens taken at the same time, although those taken at different times frequently differed greatly. The smallest of them as near as I could measure were about 1-20,000th part of an inch in diameter. A third specimen taken at the mouth of the furnace about ten minutes after charging so as not to catch any particles of dust, had also the continuous film, but much thinner, and the isolated particles were more numerous. A fourth taken from the flue about 60 feet distant from the furnace had no continuous film, but consisted only of the isolated particles, with a few flaky agglomerations of very irregular forms. As the distance from the furnace was increased the flakes became larger and more numerous, but the number of the small particles never seemed to grow less abundant.

It would appear from these experiments that as the vapourised lead cools it assumes the condition of a vast number of minute isolated particles.

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* Read before the British Association for the Advancement of Science (Section B.), Sheffield, 1879.

The state of chemical combination in which the lead in fume is either as sulphate, oxide, or carbonate, generally two or all of these together, and frequently sulphide or sulphite of lead are present in small proportions, and in special operations where chlorides are contained in the furnace charge chloride of lead may be found. Lead fume, especially that from blast-furnaces, nearly always contains a considerable quantity of alumina but very little iron. If there is silver in the ore a portion of it is volatilised with the lead. Although the loss of silver by volatilisation increases with the richness of the furnace charge in that metal, yet the loss does not increase in the same proportion, that is to say, the poorer the ore is in silver the greater is the percentage which is volatilised. This is unfortunate for those who smelt very poor lead ores containing a little silver in blast-furnaces, and produce much fume, for if it were otherwise the smelting of such ores would also be a silver concentration process. For example, a smelting charge containing 30 per cent of lead, while the proportion of silver to lead was only 18½ ozs. per ton yielded fume containing 10¾ ozs. of silver per ton of lead. In a second instance, when richer materials were being smelted, the proportion of silver to lead in the charge was 80 ozs. per ton, while the silver in the fume was 33 ozs. per ton of lead. A much richer charge containing 960 ozs. silver to the ton of lead yielded fume containing 100 ozs. silver to the ton of lead. These figures show that as the quantity of silver in the charge increases, the fume increases in richness, but not in the same proportion. I have found the fume at the end of a lead works flue 1000 yards long to contain 5½ ozs. silver per ton, while the proprietor assured me that as far as he knew the ores he smelted never contained more silver than would yield a proportion of 3 ozs. per ton of smelted lead. I only state the facts as far as I know them; the reason I cannot explain.

Lead fume appears to have no definite composition, as the proportions of its constituents vary in every specimen. The lead varies from 35 to 65 per cent. One analysis gave:—

Oxide of lead	44·80
Oxide of zinc	4·80
Oxides of bismuth and copper	1·52
Oxide of iron	trace
Alumina..	10·00
Arsenic and antimony (oxides).. ..	3·03
Sulphuric anhydride	28·81
Insoluble silicious matter	9·00
Total	101·96

Another gave:—

Oxide of lead	68·35
Sulphide of lead	2·25
Oxide of zinc	1·80
Lime	2·63
Alumina	5·40
Sulphuric anhydride	16·84
Insoluble silicious residue	2·25
Total	99·52

Lead fume besides silver invariably contains a little gold, usually from ½ to 1 per cent of the quantity of silver.

We have also found on several occasions small quantities of platinum and iridium in the fume, even in that taken from the part of the flues most remote from the furnaces. I cannot believe that the platinum and iridium were carried there in fine dust from the furnace, for in some instances the furnace was smelting rich slags only, which had come from another furnace where matters containing those rare metals were being smelted. I am well aware of the extreme minuteness of the particles of iridium after it has been alloyed with lead and then separated, but in view of the fact that platinum and iridium, especially the latter, have a particularly strong tendency to unite with sulphur compounds of lead, I incline to the belief that those metals appear in the fume as a true sublimate. We have made many experiments to ascertain what tends most to promote the settling of fume in long flues. We first examined the interior of a flue which extends for several hundred yards in a tortuous course underground. This flue besides having many abrupt turns and angles had partial stoppings of sheet-iron placed at intervals of about 15 or 20 yards. These extended to a height of about 15 inches above the floor, and contracted the area to about four-fifths at those parts. We found that at the various turns and angles, and indeed wherever an eddy of the current occurs the fume lay thickest, in some places heaped up like drifted snow.

The greatest deposition of lead fume takes place as one would expect near the furnace. By following the course of the flue from the furnace to the chimney, we find that the fume lies thickest in the first 100 or 150 yards, and generally beyond that distance it begins to diminish rapidly in quantity, until at about 400 or 500 yards it is only ⅛ as deep as in the first 100 yards. The relative distances are not alike in every case, but vary slightly according to the kind of furnace employed, the temperature of the smoke and its velocity in the flue. The subsidence of the fume appears to be promoted by whatever causes the isolated particles of which it consists when it leaves the furnace to unite into flaky masses; therefore, the more friction, buffeting, and violent agitation it suffers the more readily it settles. Cooling the smoke through a considerable range of temperature also promotes the subsidence of the fume. This is undoubtedly due to the particles being brought nearer together by the consequent contraction of the gases. I have found that the specific gravity of lead fume from a blast-furnace is about 5·5, and assuming that a cubic foot of smoke contains 4 grs. of fume, which it often does, and that the size of the particles are 1-20,000th part of an inch in diameter, we may find by a simple calculation the number of particles contained in a cubic foot, and their distances apart from each other. Thus:—

1 cubic foot of water weighs 437,500 grs.
1 ,, ,, fume ,, $437{,}500 \times 5{\cdot}5 = 2{,}406{,}250$

And as 1 cubic foot of smoke contains 4 grs. fume the aggregate space occupied by the 4 grains will be 4-2,406,250ths part of a cubic foot, or 1-348th part of a cubic inch, but the cubical contents of a sphere 1-20,000th part of an inch diameter is 1-15,278,840,000th of a cubic inch; therefore, dividing 1-348th by that fraction, we get 43,904,712, the number of particles in a cubic foot, and if we extract the cube root of this number it will be the denominator of a fraction, which, having one for its numerator, will express the distances in parts of a foot which the particles are apart, or—

$$\sqrt[3]{\frac{1}{43{,}904{,}712}} = \frac{1}{352} \text{ part of a foot,}$$

or about 1-30th part of an inch. Hence we learn that those minute particles are about 660 times their own diameter apart, and for the sake of giving a better idea of the comparative remoteness of those fume particles from each other in ordinary lead smoke, if we suppose them to be magnified to the size of the earth, then their distances apart would be 22 times greater than the distance between the earth and the moon.

We invariably find the fume is most abundant wherever the gases have suffered the greatest friction and fall in temperature. That this fact causes the fume to settle is also proved by the increased escape into the air for some time after the flues have been swept out. This I have proved by a great many assays of the smoke, and it is also apparent at the top of the chimney to the eye.

The following experiment proves the extreme difficulty of arresting lead fumes at high temperatures:—We sifted ground slags first through a sieve having 15 meshes to a lineal inch, and the portion which passed through was put upon a second sieve, having 30 meshes to the inch to remove the dust and finer grains. We then made a filter-bed with this about 1 inch thick, and aspirated a portion of the flue gases through this, taken at two points in the flue, one near the furnaces and another a considerable distance from them. The temperature at the first place was about 750° F., and although the smoke was drawn only at a slow rate the fume passed in considerable quantity, and it continued to escape after a coating of fume about 1-16 of an inch thick had formed at the surface of the filter. In the trial at the distant station, where the temperature was only 300° F., a little fume passed for the first fifteen minutes, and after that the filtration became almost perfect, and the gases then passed only very slowly. This slow passage of the gases through a dry porous filter constitutes the prime difficulty of fume condensing on that principle.

The performance of a long flue is greatly improved by having series of wide settling chambers near, but not quite, at the far end. These prevent the agglutinated particles or flakes from being swept out into the air by the draught. A flue on this principle of about 1200 or 1500 yards, inclusive of about 200 yards of chambers having a width of about two and a half times that of the flue, yields as good results as one 2 or 3 miles long. This is the principle on which the one at the London Lead Company's Works, at Nenthead, in Cumberland, is constructed. The deposition of lead fume may be seen on a small scale very well by aspiring smoke very slowly through a few feet of narrow tube kept cool by water outside, and then through a long wide glass tube placed horizontally and terminating in a wide receiver. A white deposit will be formed along the bottom of the wide tube and receiver, while the upper part, or that which represents the roof of the flue, remains perfectly clean and transparent. We soon learned by experience in our assays of the flue gases that the heavy fume tends to flow along the floor of the flue even when the velocity is as much as 6 or 7 feet per second. This requires to be kept in view when taking samples for examination.

The second class of condensers—namely, filtering through brushwood, cokes, wire netting, tangled wire, or coarse woven fabric—has frequently been attempted, but never with satisfactory results. Such material, if kept dry, does not arrest much fume until they are nearly choked up, and then the draught ceases, and if they are kept wet they scarcely stop any at all.

Our experiments on filtering were chiefly made with wet cokes. In our first we passed the smoke successively through two beds of coke, each 6 inches deep, placed one above the other. A dripping apparatus was attached to keep the cokes wet: the cokes were broken and sifted to the size of from pigeon's eggs to horse beans. The flue gases were propelled through the filter by means of a rotary blower, with a pressure equal to 5 inches of water. This was allowed to run for four days. The smoke which was sent through the filter was drawn off from the main flue at a considerable distance from the furnaces, and contained on an average ½ grain of metallic lead per cubic foot. When the filter was opened the cokes were almost clean; the water in the bottom of the apparatus contained not more than 3 ounces of fume, and after washing the cokes the total quantity did not amount to more than from one-tenth to one-twentieth of the quantity of fume which passed. We afterwards tried the effect of a greater depth of coke. Two towers, 13 feet high and 12 inches wide, were filled with pieces of coke about the size of oranges, and the smoke was sent first up the one and then down the other. An intermittent supply of water was employed to keep the cokes open.

It required a tension of twelve inches water to draw the smoke through the towers. In order to determine accurately the results of our experiments, large samples of the smoke before it entered and after it left the towers were drawn through cylinders filled with cotton-wool, and then through a long glass tube inclined at an angle of about 20°, having a bend at the lower extremity like a cooper's tube, but open at both ends. This contained a little water, which served to wash the gases after passing through the wool. The gases were drawn through the two sets of apparatus by means of an aspirator worked by steam-jet, and their quantities measured by two large gas meters.

In the above experiments the gases before entering the coke-towers yielded 545 grains metallic lead per 1000 cubic feet, and the gases escaping from the towers gave 356 grains, or 35 per cent caught. A second experiment was made, with a similar result, and as a good deal of power was required to draw the smoke through 26 feet of coke, this method was considered quite useless. It may be well to state that the question of recovering the volatilised silver was of great importance.

We next tried filtering through strong canvas cloth made up into a bag, exposing a surface of about 40 square feet, but this method did not succeed. The fume passed freely through the canvas at first, but after a short time the meshes became completely closed, and the passage of the smoke became so impeded that the experiment had to be stopped. The bag was then washed, and about 3 ozs. of fume were obtained after a run of about an hour and a half.

The following experiment shows with what great freedom lead fume escapes through cloth filters. A glass cylinder, about 1½ inches in diameter, was fitted with four calico diaphragms of gradually increasing fineness, the coarser being placed first. After aspirating the smoke through them for an hour they were removed, and each was found to have a perfect coating of fume on the side againt the current. Their order was now reversed, the finest being placed first, and using fresh cloth. After running for another hour we found the foremost and finest only had caught fume, and all the others were quite clean.

In other experiments we invariably found that smoke which had passed through a calico filter of a given fineness did not form any deposit on a diaphragm of coarser stuff, but in every case there was an escape of fume through the cloth. This was shown by the darkening of sulphide of ammonium through which the filtered smoke was made to pass.

We now come to the third class of condenser, namely, the use of water either in the form of steam or on the shower-bath principle. One of the earliest attempts to catch lead fumes in this way was made at Allenheads, near Alston Moor. There they had a long flue extending nearly three miles up a hill. Along the first hundred yards two perforated pipes were carried on each side of the flue. Small lead or copper nipples supplied a profuse shower of water. This plan did not succeed well. The small jets got stopped up with bits of straw, grass, and other organic matters, and the quantity of fume caught being no greater than it would have been in a dry flue. The plan was abandoned. The opinion is now very general amongst lead smelters that the drier a flue is the better it arrests the fumes.

The shower-bath principle is now very extensively carried out at the Wanlockhead Lead Works, belonging to the Duke of Buccleugh, in Dumfriesshire. About 2 tons of water are delivered per minute in fine jets over the smoke, while it is ascending and descending in a tortuous course through a series of tall chambers filled with earthenware drain-pipes. Very good results have been obtained from this condenser; that is to say, to obtain large quantities of fume it was found expedient to extend the flue beyond it from time to time until it has now reached a distance of one mile beyond the condenser; and the fact is of considerable importance that about one-half of the fume saved every year is obtained from the long flue, and the other half from the condenser.

Practical results accord well with the theory that raindrops, with their comparatively enormous surface tensions, are ill adapted to collect the extremely mobile particles of fume they encounter in their descent.

The use of steam in the flues as a condensing agent, although still carried on at some places, scarcely deserves notice as it is positively injurious. Most flues contain an average of about 5 per cent of moisture, and as soon as this condenses into water there is generally a notable decrease in the quantity of fume which subsides.

The fourth class of condensers consists of those which have for their principle the passing of the smoke through a body of water. This principle has been tried in various ways. The old Stagg's condenser, in which the smoke was drawn in great volumes under the surface of water by means of powerful pumping is now nearly, if not altogether, obsolete.

Our experiments showed that mere bubbling the smoke through water from a perforated pipe, for example, has little effect in stopping the fume. We made experiments to prove this, both on the large and small scale. In the large one we passed the smoke through a number of horizontal perforated pipes submerged 11 inches in water. Our assays showed that only 30 per cent of the fume was arrested. Our experiments on a smaller scale gave even worse results. The reason why simple bubbling through water succeeds no better than the shower-bath principle is that in both cases precisely the same cause operates, viz., the surface-tension of the water, which is just the same whether for a concave or convex surface of equal extent.

We can prove that fume is difficult to wet by coating a glass plate with it, and then dropping water on it while it is held at an angle of about 60° to the horizon: the drops are reflected off without wetting the plate.

This question of surface-tension was well illustrated by an experiment made at the suggestion and in the presence of Mr. Alfred E. Fletcher, one of Her Majesty's Inspectors. Equal quantities of smoke were bubbled through a wash-bottle arrangement, filled first with water, and then with ordinary rape oil. The oil, which has less than half the surface-tension of water, caught more than three times as much fume as the water.

The considerations led us to seek for some way of destroying the surface-tension of the bubbles, and we hit on the device of using fine wire gauze, made of any metal capable of resisting the corrosive action of sulphurous acid. Copper gauze answered perfectly.

In our new apparatus we use wire gauze having about 15 meshes to a lineal inch, the meshes being about 1-20th of an inch wide. A number of gauze diaphragms are arranged one above another in horizontal planes, and at small distances apart. The whole are submerged in water. The smoke is equally distributed under these by means of a horizontal series of perforated pipes. The gauze diaphragms do not add much to the resistance which the smoke current has to overcome in its passage through the apparatus; three diaphragms of the size mentioned above add about ½ an inch of water pressure. The depth of water usually employed is 7 inches above the perforated pipes, and with this depth the water gauge indicates a resistance of about 10 inches, ½ an inch only of which is due to the gauze, the remainder being due to the depth to which the smoke depresses the water at the inlet passages. The ascending gases set up an upward current of water through the gauzes, and to promote a steady circulation of this a return passage is provided.

Although we usually work with three diaphragms of wire gauze, double that number may be used without adding appreciably to the resistance, and by so doing still more perfect results may be obtained. Each square foot of area of the diaphragm space is capable of passing about 40 cubic feet of smoke per minute, and when a blast-furnace is employed for smelting lead ore about 1 foot of area will be required for each ton of ore smelted in twenty-four hours.

During the past six months almost daily assays have been made of the smoke before it entered and after it left the condenser. These have with a few exceptions exceeded 95 per cent of fume caught. The average has been 98 per cent, and in a few cases as high as 99½ per cent of the metallic contents of the smoke has been caught. After the lead has been removed from the smoke the large quantity of sulphurous acid which is usually contained in it may be recovered in a very simple manner. The gases can be mixed with a little air if enough of oxygen is not already present, and then propelled by means of a steam jet through a heating apparatus similar to the hot blast heaters used in iron smelting works, and the hot sulphurous acid steam and air passed through common salt according to Hargreaves's patent process. By this means lead or copper smoke will be rendered not more pernicious than that from ordinary chimneys. Any arsenic or zinc which reaches the condenser is dissolved in the water, and in that way separated from the lead fume, which subsides to the bottom. The apparatus was tried with hydrochloric acid vapour and condensed 97¾ per cent; of common salt vapour it condensed 93 per cent.

We use a Roots blower, with iron revolvers for forcing the smoke through the apparatus; from 2½ to 3 horse-power is amply sufficient to work a condenser large enough for a furnace to smelt 15 tons of lead ore per twenty-four hours. The weight of a condenser for that size of furnace is 18 cwts. The smoke should be cooled to about 120° to 130° F. by passing it through iron pipes, or any other kind of flue. This is necessary to prevent rapid evaporation of the water with which the condenser is supplied. It is very important to cool the smoke as far as possible so as to have a smaller volume to pass, and thereby save both power and cost of a larger apparatus.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

This Association held its twenty-eighth meeting at Saratoga Springs, N.Y., beginning August 27th, 1879. The meeting was a memorable one, both on account of the large attendance and the great value of the papers presented. The Association was honoured by the presence of an unusually large number of its Ex-Presidents, no less than nine being on the platform at one time.

The Presiding Officer, Prof. G. F. Barker, M.D., of the University of Pennsylvania, was very happy in conducting the business of the Society, his genial humour in nowise detracting from the dignity of the occasion, and serving as a pleasant refreshment.

The other officers of the Association were as follows:—Vice-President of the Physical Section, Prof. S. P. Langley, of Alleghany, Pa.; Vice-President of the Natural-History Section, Major J. W. Powell, of Washington, D.C.; Permanent Secretary, Prof. F. W. Putnam, of Cambridge, Mass. In the absence of Dr. Geo. Little, of Atlanta, Ga., Dr. H. Carrington Bolton, of Hartford, who was General Secretary at the St. Louis Meeting (1878) was continued in office.

The Chairman of the Subsection of Chemistry, Dr. Ira Remsen, of Baltimore, was unfortunately prevented from attending, and Prof. F. W. Clarke, of Cincinnati, took the position.

One of the features of these meetings is the Address of the Retiring President. On this occasion Prof. O. C. Marsh, of New Haven, had the duty to perform: his subject was "The History and Methods of Palæontological Discovery."

Vice-President Langley gave an Address on "Solar Physics," a subject to which he himself has materially contributed; and Major J. W. Powell gave an Address on "Mythologic Philosophy," having special reference to the mythologics of the Indian tribes.

Dr. Ira Remsen's Address was a plea for the study of Organic Chemistry, a branch which he claims is too often neglected in the courses prescribed in colleges and scientific schools.

These Addresses will appear in full in the annual volume of *Proceedings*.

Heartily welcomed by the meeting was the distinguished astronomer Dr. Otto Struve, Director of the Pulkowa Observatory, Russia, who is in this country for the purpose of securing a larger object lens for a refracting telescope than has yet been made in the world. The lens is to be made by Alvan Clark and Son, of Cambridge, Mass.

The lion of the gathering was undoubtedly Dr. Thomas A. Edison, of Menlo Park, N.J. He exhibited on Saturday evening, to a delighted audience of 1500 persons, his recently invented Electro-Chemical Telephone. Speech, music, &c., were transmitted from a distant room, and the sounds issuing from the telephone were heard by every individual in the hall.

Perhaps the most remarkable discovery announced was that of Dr. Edison in his paper on "The Phenomena of Heating Metals *in Vacuo* by means of an Electric Current" (*vide* Chem. News, vol. xl., p. 152), which demonstrated that platinum heated *in vacuo* by electricity becomes denser, harder, more infusible, and less liable to disintegration when heated in a flame. Iron treated in a similar manner becomes as hard as steel and just as elastic. Aluminium melts only at a white heat.

The following is a list of the papers read before the Chemical Section :—

Action of Ozone upon the Colouring-matters of Plants.—A. R. Leeds.
Bleaching of Sugar Syrups by Ozone.—A. R. Leeds.
Reduction of Carbonic Acid by Phosphorus at Ordinary Temperature.—A. R. Leeds.
Oxidation of Carbonic Oxide by Air over Phosphorus at Ordinary Temperatures.—A. R. Leeds.
Household Chemistry.—Ellen H. Richards.
On the Deterioration of Library Bindings.—Wm. Ripley Nichols.
Observations on the Variations in the Temperature and Chemical Character of the Water of Fresh Pond, Mass.—W. R. Nichols.
Percentage of Sugar in Sap of the Sugar Maple, and causes which determine its variation; with Note on Pressure of Sap.—Harvey M. Wiley.
A Modified Method of Collecting and Measuring Gases Soluble in Water.—H. W. Wiley.
Preliminary Notice of the Revision of the Atomic Weights.—F. W. Clarke.
On Graphite from the Ducktown Copper Mine.—W. L. Dudley and F. W. Clarke.
The Great Oberstein Industry: *modus operandi* of Colouring, Cutting, and Polishing Agates and Secondary Gems; illustrated by a fine collection of specimens. Mrs. Erminnie A. Smith.
Exhibition of Crystals of Sapphire from the Gem Beds of Ceylon, with brief remarks.—A. C. Hamlin.
Note on a peculiar case of Corrosion of the Metal Tin.—J. W. Osborne.
Results of Systematic Analyses of Air, designed to discover the cause of Variations in the quantity of Oxygen therein contained.—E. W. Morley.
On an Accidental Contamination of a Source of Water Supply.—W. R. Nichols.
On the Limits of Meteorological Conditions governing the extension of Beet-root Culture.—W. McMurtrie.
A Chemical Examination of Black Ozokerite.—C. Gilbert Wheeler.
Exhibition of Crystals of Sapphire from the Gem Beds of Ceylon, with brief remarks.—A. C. Hamlin.

The next meeting will be held at Boston on the last Wednesday in August, 1880, under the presidency of the eminent archæologist, Hon. L. H. Morgan, of Rochester.

Sanitary Institute of Great Britain.—The Autumn Congress of this Institute will be held at Croydon, beginning on the 21st of October. There will also be in connection with it an Exhibition of Sanitary Apparatus, Appliances, and Articles of Domestic Use and Economy. Applications for space to be sent to the office of the Curator, Mr. Charles L. Marsh, 138, Fleet Street, London, E.C., not later than Thursday, October 9th.

CORRESPONDENCE.

A NEW METHOD OF PREPARING SULPHURETTED HYDROGEN.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xl., p. 154, Mr. J. Fletcher has described what he calls a new process for the preparation of H_2S by melting sulphur and solid paraffin together. Allow me to state that the process is not new, having been used by myself and others as far back as 1872. I continued to use it for more than twelve months, but found it very unsatisfactory, because of its explosive qualities, and upon that account gave it up. As far as I remember an explosion took place about every seventh experiment; at one time the cork of the flask would be violently ejected and the contents sent to the ceiling, at other times the flask was completely destroyed.

The process works remarkably well except for this one fault, and if Mr. Fletcher has succeeded in overcoming its explosive qualities by the addition of broken tobacco-pipe shanks he has indeed rendered a service to chemists in general.—I am, &c.,

William Johnstone, F.I.C., F.C.S.

Wiesbaden, September 29, 1879.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Bulletin de la Société Chimique de Paris, No. 7, 1879.

Observations on a Notice by Prof. Widemann.—M. Schützenberger.—The author rebuts Prof. Widemann's claim to have anticipated his discovery of the existence of an allotropic modification of copper.

Reclamation of Priority on the Subject of a Memoir by M. Stempnewsky on the Preparation of Glycol.—H. Grosheintz.—The author first observed and made known the fact that during the preparation of ethylenic glycol, by the method of Hüfner and Zeller, a certain quantity of bromised ethylen makes its appearance.

Researches on the Incomplete Carbides obtained from American Petroleum.—L. Prunier.—The light petroleums, if submitted to dissociation by heat, become a source of incomplete carbides of different orders, less rich in carbon than the formenic carbide, but capable, if the action of heat is sufficiently prolonged, of re-combining among themselves so as to form more complex compounds. Among the incomplete carbons ethylen, propylen, butylen, and acetylen have been recognised. They are accompanied simultaneously by the ulterior products of their polymerisation, or of their reciprocal combination, benzol, ethyl-acetylen, or crotonyl. By a novel application of the general method of solvents the products have been fractionated according to a principle very different from that of a fractionated distillation and crystallisation. In this manner each of the industrial products may be resolved into a great number of carbides, among which are anthracen, phenanthren, chrysen, pyren, chrysogen, benzerythren, &c. Solvents such as benzol, and even petroleum if applied at a boiling heat and for a long time, fix themselves upon certain of the higher carbides, and bring them down to proportions of carbon not exceeding 94 and 95 per cent.

On Iodised Potassium Iodide.—Antony Guyard.—The author finds that this compound is a true potassium biniodide, though of great instability. Very pure methylic alcohol, and rendered slightly alkaline, gives with the biniodide of potassium an abundant precipitate of iodoform. Ethylic alcohol under the same circumstances does not give even a trace.

Action of Oxalic Acid upon Chlorates, Bromates, and Iodates.—Antony Guyard.—A boiling supersaturated solution of oxalic acid decomposes the solutions of the chlorates, bromates, and iodates very regularly, with liberation of chlorine, bromine, or iodine respectively, and enables each of these classes of salts to be recognised, not merely because the three elements are easily distinguished, but because the solution takes the colour of the gas or vapour which it contains. The bromates are partially decomposed by oxalic acid, even in the cold, whilst the chlorates and iodates require an elevation of temperature.

Process for Separating and Determining Chlorine, Bromine, and Iodine.—Antony Guyard.—The three bodies should exist in solution in the state of chlorides, bromides, and iodides. If wholly or partly present as chlorates, &c., they must be reduced by treatment with an excess of sulphurous acid. The mixture, acidulated with sulphurous acid, is treated with a slight excess of a mixture of bisulphite of soda and sulphate of copper. The iodine is precipitated immediately and very completely as cuprous iodide, in which state it may be directly determined with much accuracy. The results are liable to be erroneous only in presence of sulpho-cyanides—a circumstance not to be expected in practice. After filtering off the cuprous iodide the liquid is boiled with an excess of sulphuric acid until all the sulphurous acid of the sulphites has been completely expelled. When this is effected the liquid is introduced into a flask which communicates, by means of a bent tube, with a Will and Varrentrapp's nitrogen-tube. Into this is introduced a solution of bisulphite, or of sulphurous acid, or bisulphide of carbon, or, if it is preferred, a solution of potassium iodide, and the tube is kept in cold water. To the liquid in the tube is added a small excess of pure chromic acid, or a mixture of sulphuric acid and potassic bichromate, and the liquid is boiled until the bromine is completely expelled. It is then determined, either as bromide of silver, or by a colorimetric process, or indirectly by the volumetric determination of the iodine which it liberates. To determine the chlorine it is merely needful to reduce the excess of chromic acid by means of a sulphite, and to precipitate with silver nitrite.

Decomposition of Hydracids by Metals.—M. Berthelot.

Reciprocal Displacements between Oxygen, Sulphur, and the Halogens combined with Hydrogen.—M. Berthelot.—These two papers have been already noticed.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.

No. 67, July, 1879.

Report by M. de Luynes on M. C. Lorilleux's Manufacture of Printing and Lithographic Inks.—Two kinds of varnish are employed in the manufacture of printing inks; the ene obtained by boiling linseed oils, and the other from a mixture of resin and resin oil, the latter being chiefly used for newspapers where rapid drying is of importance. M. Lorilleux allows his linseed oil to rest for two years at a constant temperature. It is then boiled by means of hot air, at a distance from the furnaces so as to remove every risk of fire. A mass of 2500 kilos. is boiled from twenty-four to fifty-six hours, and is stirred by a mechanical agitator. The varnish thus obtained is limpid and flows well. The lamp-black is produced either by means of specially constructed lamps or by the decomposition of naphthalin oils, which fall by drops into a heated retort. The gaseous products are carried off by tubes, at the end of which they are burnt under sheet-iron bells, whilst the black is carried off by a current of air into large chambers. It is afterwards submitted to calcination. All the inks, lithographic or typographic, are submitted to a practical trial before being sent out.

Biedermann's Central-blatt für Agrikultur-Chemie.

August, 1879.

Researches on Damage to the Soil and the Crops by the Waste Waters and the Gases from Manufactures.—Dr. J. König.—These researches relate, in the first place, to the waters from certain mines of zinc-blende in Westphalia, which pass into certain streams used for irrigation, and seriously injure the productiveness of the soil. The presence of zinc oxide in the earth is indicated by the prevalence of *Viola calaminaria*, which contains in its ash as much as 21 per cent zinc oxide. The author has likewise examined the waste waters from a dye works, a wire works, and from pyrites washing. The two latter he considers as directly poisonous to plants on account of their percentage of ferrous sulphate. The dye water may, by reason of the organic matters which it holds in solution or suspension, gradually overload the soil with humus and render it boggy.

The Transformations of Silicates.—Dr. J. Lemberg.—In the first section of this dissertation the author gives a series of analyses of minerals in various stages of transformation and weathering. In the second, he takes up the questions first raised by Berthollet concerning the influence of masses in chemical action. His experiments confirm the views of the French chemist. In the reactions of common salt upon gypsum, of alkaline and magnesian chlorides upon calcium carbonate, there are formed not merely two new compounds by double decomposition but all the four compounds possible in such cases are produced in quantities which vary with the proportions of the salts originally employed. In the third section the author contends that basic felspars weather easily, but those of an acid character with difficulty. In his fourth section he examines whether in the absorptive action of soils peculiar forces come into play, as Liebig maintains, or whether, as Way and Mulder suppose, the phenomena are due to purely chemical action. In the fifth and last section the author describes experiments in which silicates were added to melted chlorides of potassium, sodium, and calcium, and to sodium sulphate, and gives an account ot the changes observed.

Researches on the "Clover Sickness" of Soils.—Dr. A. Emmerling and Dr. R. Wagner.—A soil of this kind was found deficient in phosphoric acid and especially in potash.

Experiments on the Excretion of Gaseous Nitrogen from the Albuminates Transformed in the Animal System.—J. Seegen and J. Nowak.—The authors conclude from their experiments that the animal organism is capable of excreting in the gaseous state a part of the nitrogen liberated on the transformation of the albuminates.

Reimann's Färber Zeitung,

No. 31, 1879.

This issue contains nothing of general interest.

No. 32, 1879.

Vegetable Silk.—A. Müller.—The author, after referring to the fact established by Mulder, that silk when dissolved in cupric oxide, glycerin, &c., is not decomposed, and can be precipitated unchanged, chemically speaking, mentions a patent which he obtained in 1871 for dissolving silk waste and precipitating it upon vegetable fibre.

No. 33, 1879.

A great part of this issue is taken up with complaints concerning the unremunerative state of the dyeing business in various parts of Germany.

A serious, probably fatal, explosion of benzin (benzol or light petroleum-spirit?) took place in a dye-house at Blankenburg. The cause of the calamity is not specified.

No. 34, 1879.

The spinning works of Steinbrecher in Trübau have been since last year lighted up with the electric light. The dye-houses in Spindler's establishment at Spindlersfeld are about to be illuminated in the same manner.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 8, 1879.

Determination of Atomic Weights and the Utilisation of Isomorphism for this Purpose.—Hermann Kopp.—This important memoir, which extends to upwards of fifty pages, is unfortunately not capable of useful abstraction.

New Determination of Manganese with the Application of Volhard's Process for the Titration of Silver.—C. Rössler.—The solution containing the manganese in the state of a proto-salt, free from chlorine or other halogen and from organic matter, is placed in a flask holding a half or a quarter litre. A measured quantity of a solution of silver of known strength (10·8 grms. silver per litre) is then added, the quantity being greater than what is requisite for the precipitation of the manganese. The flask is then heated in the water-bath, and a solution of carbonate of soda is added, till not only the black compound but the excess of silver is perfectly precipitated. Ammonia is then added, avoiding excess (about 10 c.c., at sp. gr. 0·958, to every 50 c.c. of the silver solution); the flask is shaken, cooled, filled with water up to the mark, and well shaken. The contents are then filtered through a folded filter into a dry beaker, and the silver present in a measured volume is determined by Volhard's sulphocyanide process, the liquid having been previously acidulated with nitric acid. The quantity of silver solution needed for the precipitation of the manganese present is then found by calculation, 1 c.c. representing 0·00275 grm. of manganese.

Percentage of Sulphuric Acid in Wine.—G. Lunge.—The author points out that Prof. Nessler, led astray by the misprint "centigrammes" for "milligrammes," in an essay by Marty in the *Journal de Pharm. et Chimie*, has declared that no wine ought to be condemned as plastered unless it contains per litre more than 3·28 grms. $SO_4H_2 = 5·83$ grms. potassium sulphate. The serious nature of the error will appear on remembering that Prof. Nessler himself only once met with a sample of natural wine containing as much as 0·063 per cent $SO_3 = 1·36$ grms. potassium sulphate per litre.

New Colouring-matters.—Otto N. Witt.—If the solutions of molecular quantities of meta-toluylen-diamin and nitroso-dimethyl-anilin hydrochlorate in warm water are mixed, there is formed a deep blue liquid, from which a colouring-matter can be precipitated by means of salt. The substance obtained, $C_{15}H_{18}N_4HCl+H_2O$, dissolves readily with a bright blue colour in cold water, alcohol, and glacial acetic acid. By the use, on the one hand, of ortho- and para-toluydin, of the isomeric toluylin-diamin and xylidin, and, on the other, of nitroso-dimethyl-anilin, nitroso-phenol, and of the other known nitroso-compounds, the author has obtained a number of other new colours, with whose investigations he is now engaged.

On Phosphorus Sulphides.—G. Ramme.—The author obtained the penta-sulphide from a solution of sulphur and phosphorus in carbon sulphide. The preparation of the trisulphide in the same manner did not succeed, nor was P_4S_3 (Lemoine) formed.

Artificial Atropin.—A. Ladenburg.—The author has effected the synthesis of atropin from its decomposition products, tropin and tropic acid.

On Tropidin.—A. Ladenburg.—In his investigations of tropin the author has discovered a new base, tropidin, which appears to have a considerable analogy with coniin. He thinks it possible to obtain coniin from tropidin by the addition of hydrogen.

Certain Derivatives of Tropic Acid.—A. Ladenburg.—The derivatives in question are tropide, tropic ether, and chlorhydro-tropic acid.

On Di-isobutylamin.—A. Ladenburg.—The author's observations differ from those of Reimer.

Derivatives of Ortho-toluylen-diamin.—A. Ladenburg and L. Rügheimer.—The authors have studied the behaviour of ortho-toluyden-diamin with acetophenon and with acetic ether.

On Cuprous Chloride.—M. Rosenfeld.—It is commonly stated that this compound is converted into copper sulphate by the action of concentrated nitric acid. In the cold, however, there is no action, and even with the aid of heat very little. Partially oxidised cuprous chloride can be rendered colourless by washing in glacial acetic acid. In dilute nitric acid cuprous chloride remains colourless if light be excluded. It is exceedingly susceptible to light. The author describes certain chromates of copper, with whose further investigation he is engaged.

Action of Chlorine upon Naphthalin-β-sulphonchloride and a New Trichlor-naphthalin.—Oscar Widmann.—A description of the tetra-chloride of naphthalin-β-sulphon-chloride, of dichlor-naphthalin-β-sulphon-chloride, and of ζ-trichlor-naphthalin.

Dichlor-naphthalin-β-sulphonic Acid and its Salts.—O. Widmann.—The acid in question is powerful and expels carbonic acid from its salts. Its potassium, ammonium, silver, barium, lead, manganese, zinc, and copper salts are described.

On Nitroso-sulph-hydantoin.—R. Maly.—Nitroso-sulph-hydantoin is characterised by forming with bases bright yellow, orange, and red compounds, which are not true salts.

Decomposition of Ammonium Formiate at High Temperatures.—R. Andreasch.—The chief decomposition-product of formiate of ammonia is not hydrocyanic acid, but formamide. Of the former body only traces are perceptible.

A New Base, $C_{19}H_{18}N_2$.—C. Böttinger.—This base is obtained as a product of the reaction of benzol-chloride with aniline. On heating the base with mercuric chloride or with arsenic acid it is converted into a true colouring-matter. In the former case the solution is first clear, and then reddens, the colouring-matter being developed with a brisk reaction. The crude dye is a reddish violet.

Action of Ammonia upon Quinons.—E. v. Sommaruga.—The author has made a number of experiments on the action of ammonia upon the reduction-products of the quinons. From dioxy-indol, the reduction-product of isatin, he has isolated two colourless crystalline bodies and a fine crystalline red dye.

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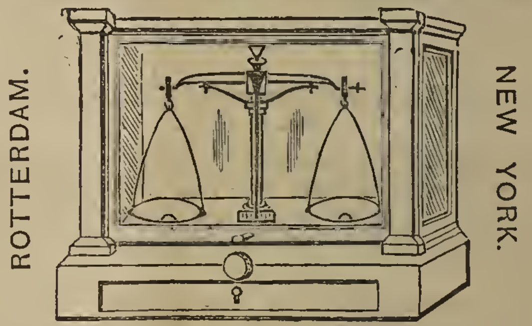

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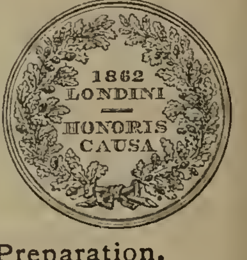

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THE CHEMICAL NEWS.

Vol. XL. No. 1037.

ON THE NON-EXISTENCE OF NASCENT HYDROGEN.

Reduction of Potassium Perchlorate.

By Dr. D. TOMMASI.

A solution of chemically pure potassium perchlorate was submitted to the action of various reducing agents, and the following results were obtained:—

(1.) The perchlorate treated with zinc and dilute sulphuric acid at the ordinary temperature, is not transformed into chloride, even by the aid of heat.

(2.) Magnesium and dilute sulphuric acid do not reduce the perchlorate, either in the cold or by the aid of heat.

(3.) A certain quantity of perchlorate was dissolved in a concentrated and boiling solution of copper sulphate. Into this solution a piece of zinc was plunged, and immediately a violent reaction took place, and hydrogen was freely evolved, but the perchlorate underwent no reduction. Neither does any reduction take place when the perchlorate is treated with sodium amalgam, zinc and potash by the aid of heat, &c., nor, indeed, with any of the principal reducing agents in ordinary use.

Now, this perchlorate which undergoes no reduction, although found in the presence of *nascent hydrogen*, is easily transformed into chloride by the action of a compound which does not set hydrogen free, viz., sodium hydrosulphite. The action of sodium hydrosulphite doubtless takes place according to this equation:—

$$4SO_2HNa+ClO_4K=KCl+4SO_3NaH.$$

During the action of zinc on sodium bisulphite no hydrogen is evolved, but let us, on the contrary, admit that some is produced. How, then, can it be explained that this same perchlorate, which undergoes no reduction by means of nascent hydrogen, as shown by sixteen different reactions, can be reduced by the hydrogen disengaged by the action of zinc on sodium bisulphite.

M. Würtz, in his *Atomic Theory*, declares himself to be in favour of the nascent state of bodies, and he explains it in these terms:—

"The special activity of hydrogen and oxygen gas *in the nascent state* is without doubt due to the circumstance that in this case the atoms act separately before being united to a congener in order to form the couples of which the molecules are composed. It is evident that this formation, which is a combination, ought to evolve heat. The separate atoms which are nascent, and not yet united to their fellows, are still provided with that heat, and are, as a consequence, so much the more active." That the atoms of hydrogen are more active than its molecule we do not deny. It appears to us, however, unlikely that when the hydrogen is set free by a reaction, it can be in the state of *isolated atoms*.

We know that copper, even finely divided, is very slightly attacked by hydrochloric acid at the ordinary temperature. Copper hydride, on the contrary, is decomposed very energetically.

"How can this fact be explained," justly remarks M. Würtz, "if, to the affinity of chlorine for copper, be not added the affinity of the two atoms of hydrogen to form a molecule?"

But how are we then to understand that the hydrogen set free by this reaction can be found in the state of isolated atoms, since it is the very affinity of the two atoms of hydrogen that determines the reaction between the hydrochloric acid and the copper hydride?

What has just been said for copper hydride and hydrochloric acid may be said equally for all the reactions producing hydrogen,—say, for example, the action of hydrochloric acid on zinc—

$$ClH+ClH+Zn=ZnCl_2+HH.$$

In this case, as we know, there neither is nor can be any hydrogen in the state of *isolated atoms*, as M. Würtz thinks, and the special properties of nascent hydrogen can be attributed only to the calories which accompany hydrogen while it is being set free.

Are we therefore to conclude that hydrogen can be active only in the molecular state? Certainly not; for hundreds of examples prove to us, on the contrary, that in many cases it is not the molecule of hydrogen that acts, but its atom.

An isolated atom cannot exist, and consequently it is devoid of properties. For an atom to exist it would be necessary for its molecule to contain only a single atom, as in the case of mercury, which in all probability is confounded with its atom.

Dr. J. H. Gladstone and Mr. A. Tribe have recently found that there is a great analogy between the effects produced by nascent hydrogen, occluded hydrogen, and those obtained by the copper-zinc couple.* We are happy to find that the result of their researches coincides entirely with our hypothesis, which, as is well known, considers the different allotropic states of hydrogen as ordinary hydrogen in different physical conditions.†

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SOME EXPERIMENTS WITH VARTRY WATER.

By JOSEPH FLETCHER, F.C.S.,
Membre de la Société Chimique de Paris, &c.

There is a Royal Commission now sitting to investigate the causes of the excessive death rate in Dublin, and although its principal business is with the public drainage and house sanitation, still the results of recent experiments with the water supply of the city may not be unwelcome to some of your readers who take an interest in such matters.

The City of Dublin, and several of the outlying townships, are supplied from an artificial reservoir formed by damming the valley of the River Vartry. The works are on a large scale, and the supply is very abundant, allowing of a constant service at high pressure, besides a very large margin for waste. It is a water which upon analysis shows very little chlorine, 0·001155 per litre, or 0·8025 grains per gallon, which quantity is remarkably constant. It is of great softness, the hardness being only 3 degrees on Clark's scale, and yielding a total solid residue, varying, as the result of many experiments, from 4 grains to 6 grains per gallon.

Two questions have been raised about this water. One is that it is largely contaminated with peat, and the other that its action upon lead is considerable. My experiments were made to throw some light upon these points.

The Vartry is admittedly a peaty water, purified more or less by filtration; but in the early mornings, when the service taps are first opened, it is often of a coffee colour, and vegetable filaments are abundant. I rejected such, and took my samples at mid-day, when the water was uniformly clear. I have found an excellent means of observing the colour is to employ an inverted glass fern shade fixed upon a suitable stand, and filled with the water to be examined. It requires a good many litres to fill it, but where waters are studied at their source that does not matter. Samples which in the quart decanter and the 2-foot tube appear clear, or at most faintly turbid, when

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* *Journal of the Chemical Society*, April, 1879; Chemical News, vol xxxix., p. 91.

† *Les Mondes*, September 11, 1879.

viewed at a proper angle (from above through the concavity at the side of the apparatus) show a decidedly peaty tinge. This is very evident in the Vartry water. 500 c.c. of the water evaporated gently to 50 c.c. presents the appearance of a strong solution of peat, large flocculi floating in the fluid: filtered, they remain upon the filter, and the filtrate showed a corresponding reduction of solid residue.

My principal object, however, was to investigate the action of the water upon lead. The pieces of metal employed were rolled so as to fit easily into a glass tube connected with the main supply. They were carefully washed in distilled water, dried in an air-bath at low temperature before and after the experiments, and handled as little as possible. The pressure at the tap was unfortunately not regular, which will account for some apparent discrepancies, but this will be arranged in future experiments.

A piece of lead 12·7 × 7·6 centimetres, placed in the tube for 36 hours lost 70 milligrms.; in another 12 hours it again lost 70 milligrms.; 48 hours, nothing; 30 hours, 40 milligrms.; total loss in 126 hours, 180 milligrms.

A second piece, 8·5 × 5 centimetres—After 26 hours lost 15 milligrms.; in another 22 hours it further lost 40 milligrms; 48 hours, 15 milligrms.; 36 hours, 40 milligrms.; total loss in 132 hours, 110 milligrms.

The piece employed in experiments No. 2 was cleaned and polished—After 32 hours it lost 5 milligrms.; in another 26 hours it lost 10 milligrms.; 48 hours, 10 milligrms.; 60 hours, 20 milligrms.; total loss in 166 hours, 45 milligrms.

Several experiments were then made with pieces of lead in still water, the principal being 14 × 2·5 centimetres.

After 24 hours it gained 10 milligrms.; after another 27 hours it gained another 10 milligrms.; and after another 56 hours it remained without change.

The same piece, taken from the still water and placed in the tube—After 48 hours it lost 20 milligrms.; after another 24 hours it lost another 10 milligrms.; total loss in 72 hours, 30 milligrms.

Again, a piece of lead 7·5 centimetres square was placed in a glass dish, into one end of which a stream of water was allowed to flow, but not in immediate contact with the current: there was no change after four days.

The results of these experiments indicate a water of great purity, chemically considered, but strongly impregnated with peat, having a very decided action upon lead when flowing through pipes of that material, but without action upon it when at rest, but rather leaving an organic deposit.

I am making further experiments upon this water, which I shall have pleasure in submitting.

ON SOME POINTS IN CONNECTION WITH AGRICULTURAL CHEMISTRY.

At the recent meeting of the British Association for the Advancement of Science, held at Sheffield, Dr. Gilbert, at the request of the President of the Chemical Section, gave some account of results obtained at Rothamsted, of which the following is briefly the substance:—He stated that, in the course of the experiments conducted there, wheat had now been grown for thirty-six years in succession on the same land, barley for twenty-eight years, oats for nine years, root-crops for more than thirty years, and beans also for about thirty years. Experiments on an actual course of rotation had extended over thirty-two years; and, lastly, experiments had been conducted on the mixed herbage of grass land, in Mr. Lawes's Park, for twenty-four years. They found minor distinctions in the manurial requirements of different plants of the same natural family, but very great distinctions in the requirements of plants of different natural families. The gramineous crops are very low in their percentage of nitrogen, and yield but a small quantity of it per acre. Yet nitrogenous manures are very effective when applied to such crops. Leguminous crops, on the other hand, are very high in the percentage of nitrogen, and yield a large amount of it per acre. Yet nitrogenous manures are of little avail to those plants, and potash manure is especially effective. The difference in the manure-requirements of plants of some other natural families was also pointed out.

Much more complicated, however, was the problem, when experiments were made upon the mixed herbage of grass land, where they might have fifty or more species growing in association, representing perhaps twenty natural families. It was at once found that the manures which most favoured gramineous crops, grown separately on arable land, brought forward the gramineous plants in the mixed herbage. Those, on the other hand, which favoured the Leguminosæ, grown separately on arable land, brought forward the Leguminosæ in the mixed herbage. The plants of other natural families also exhibited characteristic susceptibility to the manures employed. In fact, any manure—that is, anything that increases the growth of any species—induces a struggle, greater or less in degree, causing a greater or less diminution, or a disappearance, of some other species. Hence the twenty different plots, in the experiments in question, soon showed as many distinct floras. Tables were exhibited illustrating the variation in the number of species, which was in some cases fifty and in others under twenty; and the percentage by weight, and the amounts per acre, which the different natural families yielded, were also shown.

There were very great differences, not only in the flora, but also in the character of development of the plants, degree of luxuriance, tendency to form leaf or stem, to mature or otherwise, and so on; and, with these, there were also very great differences in the chemical composition of the produce. The dry matter of the mixed herbage contained, per cent, in some cases 1½ times as much nitrogen as in others; and the amount of nitrogen in the produce per acre was three times as much in some cases as in others. The percentage of potash in the produce varied as one to two, and the amount of potash yielded per acre as one to five, in the different experiments, and there were considerable differences among the other constituents. The produce of the respective natural families, when normally developed and when ripe, may be said to possess a characteristic composition within certain limits. Yet the composition varied immensely according to the conditions supplied, the species grown, and the character of development induced. Thus, the ash of the separated gramineous produce showed a variation in the percentage or potash of from about 24 to about 40; the ash of the leguminous produce, from 12 to 33; and that of the mixed produce of the other natural families, from 17 to 37.

One point of especial interest was the difference in the amount of nitrogen taken up over a given area by plants of different natural families. The measurable, or as yet measured, annual deposition of combined nitrogen from the atmosphere was quite inadequate to account for the amounts taken up by the vegetation. Even unmanured land may lose more than this by drainage. It was assumed by some that some plants assimilated the free nitrogen of the atmosphere, whilst others did not; and if this were established many existing difficulties would be explained away. But Mr. Lawes and he (Dr. Gilbert) considered that the balance of the direct experimental evidence on the point was decidedly against the supposition of the assimilation of free nitrogen. The balance of existing indirect evidence was also in favour of the supposition that the different plants only took up combined nitrogen, and chiefly from the soil. It was shown, by reference to their experiments at Rothamsted, that in the growth of wheat or barley for many years in succession on the same land, without nitrogenous manure, the annual yield of nitrogen in the crop gradually diminished. With this there was a diminution in the percentage of nitrogen in the soil. In the case of the root-crops, where, under similar conditions, the diminution in the annual yield of nitrogen was greater than in the case of the cereals, the diminution in the percentage of the nitrogen in the soil was also greater. In the case of beans there was also a diminution in the yield of nitrogen in the crop, but still much more was yielded over the later period than in either wheat or barley. The bean-field did not, however, show a marked reduction of nitrogen in the surface soil. In the case of the mixed herbage experiments very much more nitrogen was yielded by the application of potash manure, in great part due to the increased growth of leguminous plants; and here they found a great reduction in the percentage of nitrogen in the soil. In the case of clover, grown for many years in garden soil, the percentage of nitrogen in the soil was also very largely reduced. Part of this reduction might be due to loss by drainage, and in other ways; but the indication was that the Leguminosæ had derived their nitrogen from the soil.

Admitting that the sources of the whole of the nitrogen of vegetation were not conclusively made out, they nevertheless considered that the existing evidence was against the idea of the assimilation of free nitrogen by plants, and in favour of the opinion that the nitrogen was mainly, if not entirely, derived through the medium of the soil. Independently of the combined nitrogen which soils receive from the atmosphere, or by manure, most have large accumulated stores derived from past ages of vegetation, with perhaps greater normal annual supplies than at present, and certainly less removal, and therefore gradual accumulation. On this point it may be mentioned that a sample of Oxford clay, obtained in the recent Sub-Wealden exploration boring, at a depth of between 500 and 600 ft., showed, on analysis at Rothamsted, approximately the same percentage of nitrogen as the subsoil at Rothamsted taken to a depth of about 4 feet only. An acre of moderately clayey soil and subsoil may indeed contain several thousand pounds of combined nitrogen within the depth to which the roots of growing crops descend.

ON THE FORMATION OF ROSANILINE.

By JUSTUS WOLFF.

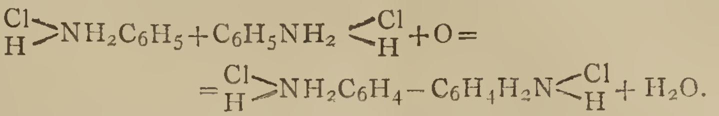
The chemical process of the formation of rosaniline is much more complicated than it appears, and it is worth while to examine it in all its details.

In order to manufacture magenta, a suitable mixture of aniline and toluydine is treated at an elevated temperature with an oxidising or dehydrogenating agent, which is an acid by itself, or with a neutral or basic oxidiser or dehydrogenator in presence of an acid. The presence of an acid is one of the first conditions for the formation of rosaniline: without acid no rosaniline can be formed. The action of the oxidiser or dehydrogenator takes place at a temperature equal to the boiling-points of aniline or toluydine, or their mixtures.

Aniline possessing the lowest boiling-point in that mixture will be acted upon in the first instance, until the boiling-point of a mixture of 2 molecules of aniline and 1 molecule of toluydine is reached, whereafter that mixture will be dehydrogenated, and so on. In the aniline salt, which is acted upon by oxygen or any other dehydrogenator, the nitrogen is in a pentadic state, and therefore its nucleus forms with the acid a stable compound, which is not dissociated at the temperature of the boiling-point of aniline, consequently the oxidiser can act only on the phenyl nucleus of the aniline, eliminating one hydrogen.

Oxygen, being a dyad, requires two hydrogens, and therefore one oxygen will act on the phenyl-nuclei of two molecules of aniline salt, eliminating one hydrogen of each phenyl nucleus, and producing in each of them one free atomicity, by which they combine together.

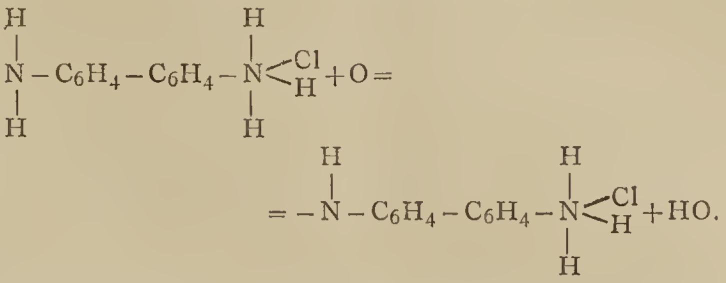
For the sake of simplicity I take in the following formulæ hydrochloric acid as the acid combined with aniline:—



$$\substack{Cl\\H}\!>\!NH_2C_6H_5+C_6H_5NH_2<\!\substack{Cl\\H}+O=$$
$$=\substack{Cl\\H}\!>\!NH_2C_6H_4-C_6H_4H_2N<\!\substack{Cl\\H}+H_2O.$$

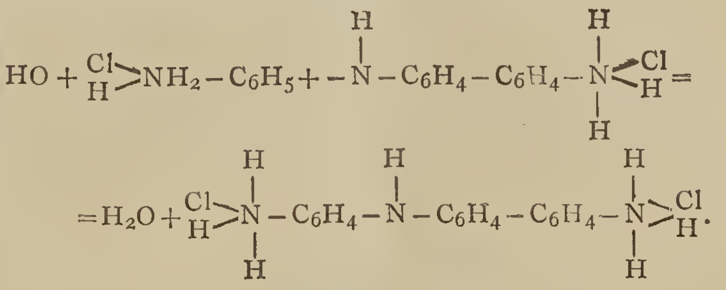
The resulting molecule represents an aniline, in which one hydrogen is substituted by the complex $C_6H_4NH_2$, and therefore it can saturate only one acid molecule, especially at the high temperature of 182°.

On that account the acid contained in the dehydrogenated aniline, which is substituting one hydrogen in the original aniline, will separate from its nitrogen appendix, whereby the latter is exposed to the action of the oxidiser and loses one of its hydrogens.



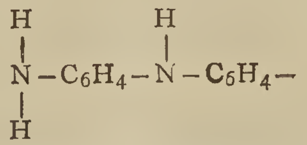
$$\overset{H}{\underset{H}{N}}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<\!\substack{Cl\\H}+O=$$
$$=-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<\!\substack{Cl\\H}+HO.$$

Here we have a compound molecule with one free affinity, besides an oxygen compound with a free affinity too. The latter acts on a new molecule of aniline salt, eliminating one hydrogen of its nucleus, and thus produces a compound with a free affinity, by which it will combine directly with the above molecule.



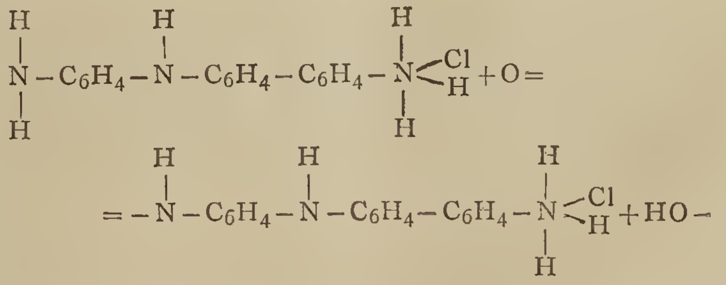
$$HO+\substack{Cl\\H}\!>\!NH_2-C_6H_5+-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<\!\substack{Cl\\H}=$$
$$=H_2O+\substack{Cl\\H}\!>\!\overset{H}{\underset{H}{N}}-C_6H_4-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}>\!\substack{Cl\\H}.$$

The last-formed molecule represents an aniline, in which one phenyl nucleus hydrogen is substituted by the complex—



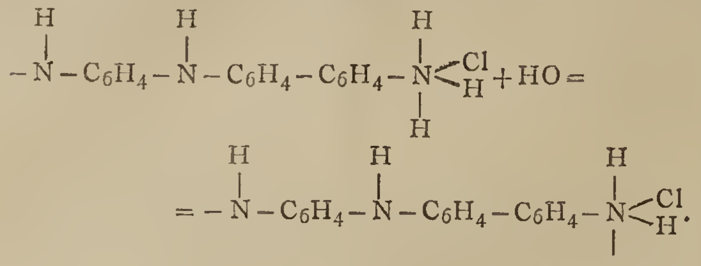
$$\overset{H}{\underset{H}{N}}-C_6H_4-\overset{H}{N}-C_6H_4-$$

As such it is not able to combine with more than one acid molecule, especially at the high temperature of 182°, and therefore it will separate with the last added acid molecule, by which reaction a change of atomicity of the next situated nitrogen is produced, and consequently the respective nitrogen appendix dehydrogenated—



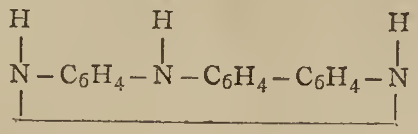
$$\overset{H}{\underset{H}{N}}-C_6H_4-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<\!\substack{Cl\\H}+O=$$
$$=-\overset{H}{N}-C_6H_4-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<\!\substack{Cl\\H}+HO-$$

In this complex the acid is completely saturated, and is not able to take up another phenylene compound, and therefore the hydroxyl will not act upon a fresh molecule of aniline salt but on the above compound, and will eliminate one hydrogen of it, which latter is offered for this action in the nitrogen appendix NH_2, joined to the acid molecule.



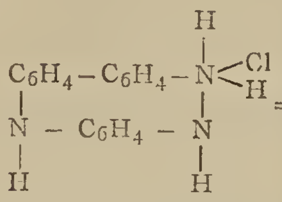
$$-\overset{H}{N}-C_6H_4-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<^{Cl}_{H}+HO=$$
$$=-\overset{H}{N}-C_6H_4-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{|}{N}}<^{Cl}_{H}.$$

The last given compound has two free atomicities in its nitrogen appendices, which therefore will combine together, and thus form a closed chain or ring, representing the violaniline molecule—



$$\overset{H}{\underset{|}{N}}-C_6H_4-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{|}{N}}$$

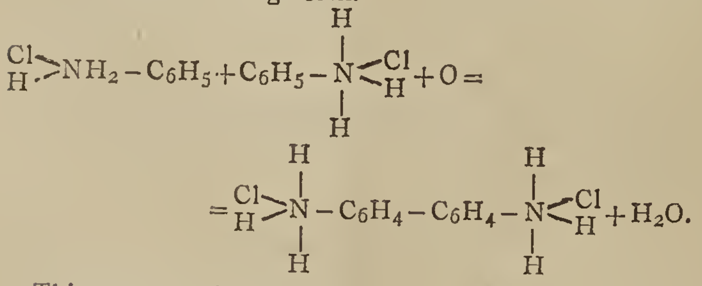
Or—



$$\begin{array}{l} C_6H_4-C_6H_4-\overset{H}{N}<^{Cl}_{H}\\ |\qquad\qquad\qquad |\\ \underset{H}{N}-C_6H_4-\underset{H}{N}\end{array}=\text{Violaniline hydrochloride.}$$

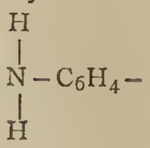
The formation of violaniline starts at a temperature equal to the boiling-point of aniline, and ends as soon as the boiling-point of a mixture of two molecules aniline and one molecule toluydine is reached, viz., 188°. From 188° upwards begins the formation of mauvaniline in a manner similar to that of violaniline.

In such a mixture the oxygen acts in the first instance on that part which possesses the lowest boiling-point, consequently on the aniline. Two molecules of aniline being present, the oxygen acts on the two phenyl nuclei of them by eliminating one hydrogen of each, in consequence of which they combine together by their free atomicities, which are thus coming forth.



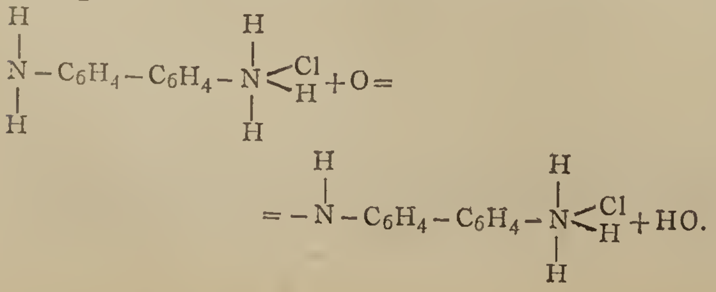
$${}^{Cl}_{H}>NH_2-C_6H_5+C_6H_5-\overset{H}{\underset{H}{N}}<^{Cl}_{H}+O=$$
$$={}^{Cl}_{H}>\overset{H}{\underset{H}{N}}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<^{Cl}_{H}+H_2O.$$

This compound, representing an aniline, in which one hydrogen is substituted by—



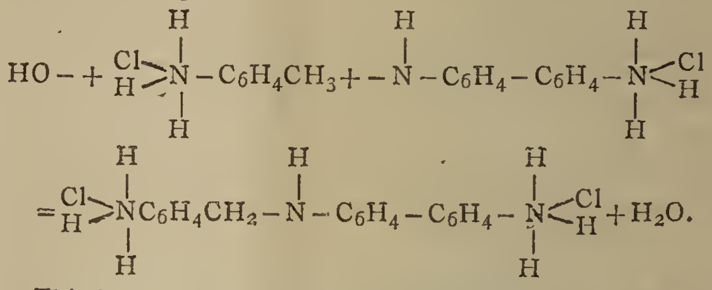
$$\overset{H}{\underset{H}{N}}-C_6H_4-$$

can therefore combine with only one acid, and on that account has to separate with the other acid molecule. In that manner a change of atomicity takes place in the nitrogen, and in consequence of it this nitrogen appendix will be acted upon by the dehydrogenator, eliminating one hydrogen of it.



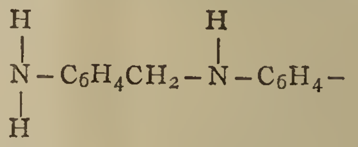
$$\overset{H}{\underset{H}{N}}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<^{Cl}_{H}+O=$$
$$=-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<^{Cl}_{H}+HO.$$

The last compound, not being able to saturate the acid molecule completely, and possessing one free atomicity in presence of a dehydrogenator, the latter will act on a fresh molecule, which in this case is toluydine, and eliminate one hydrogen of its methylene appendix, thus creating a free atomicity in it, by which the toluene compound joins the above complex.



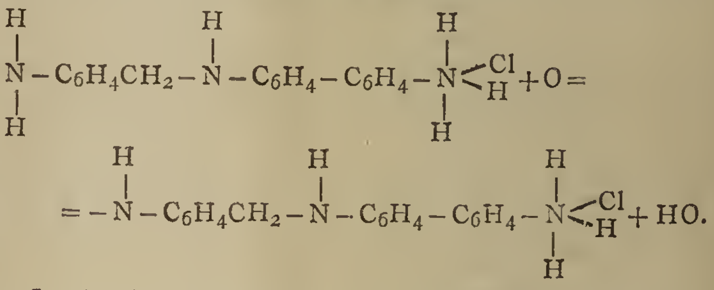
$$HO-+{}^{Cl}_{H}>\overset{H}{\underset{H}{N}}-C_6H_4CH_3+-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<^{Cl}_{H}$$
$$={}^{Cl}_{H}>\overset{H}{\underset{H}{N}}C_6H_4CH_2-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<^{Cl}_{H}+H_2O.$$

This last compound represents an aniline, in which one hydrogen is substituted by the complex—



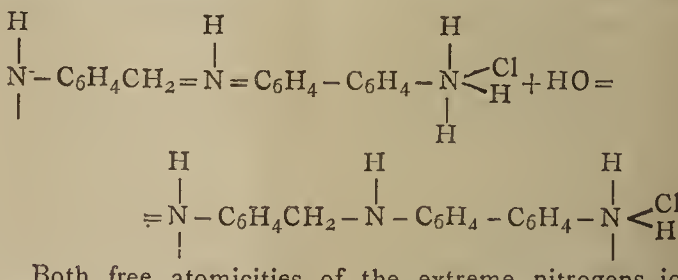
$$\overset{H}{\underset{H}{N}}-C_6H_4CH_2-\overset{H}{N}-C_6H_4-$$

and which therefore can combine with only one acid molecule, and on that account it has to separate with its second acid molecule. By this action the nitrogen next to this second acid molecule changes its atomicity, and is subsequently acted upon by the oxygen, and one of the hydrogens combined with it is eliminated.



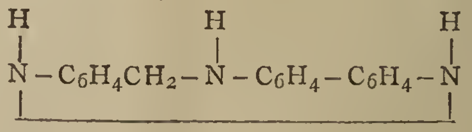
$$\overset{H}{\underset{H}{N}}-C_6H_4CH_2-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<^{Cl}_{H}+O=$$
$$=-\overset{H}{N}-C_6H_4CH_2-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<^{Cl}_{H}+HO.$$

In that last compound the acid molecule is completely saturated, and therefore the compound cannot take up another phenylene nucleus, on account of which the hydroxyl does not act on a fresh aniline or toluydine salt, but on the compound itself, by eliminating a hydrogen, which can only be that in the NH_2 appendix, nearest to the acid molecule—



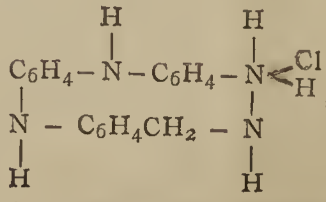
$$\overset{H}{\underset{|}{N}}-C_6H_4CH_2=\overset{H}{N}=C_6H_4-C_6H_4-\overset{H}{\underset{H}{N}}<^{Cl}_{H}+HO=$$
$$=\overset{H}{\underset{|}{N}}-C_6H_4CH_2-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{|}{N}}<^{Cl}_{H}.$$

Both free atomicities of the extreme nitrogens join themselves together, thus forming a closed chain, representing mauvaniline.



$$\overset{H}{\underset{|}{N}}-C_6H_4CH_2-\overset{H}{N}-C_6H_4-C_6H_4-\overset{H}{\underset{|}{N}}$$

Or—

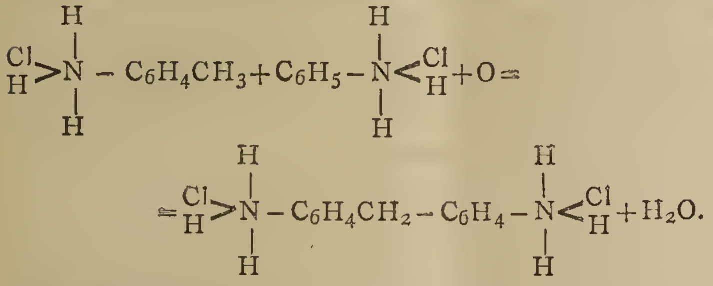


$$\begin{array}{l} C_6H_4-\overset{H}{N}-C_6H_4-\overset{H}{N}<^{Cl}_{H}\\ |\qquad\qquad\qquad\qquad |\\ \underset{H}{N}-C_6H_4CH_2-\underset{H}{N}\end{array}=\text{Mauvaniline hydrochloride.}$$

As stated above, the formation of mauvaniline begins at about 188°, and goes on until the boiling-point of a mixture of one molecule of aniline and two molecules of toluydine, viz., 193°, is reached, at which point commences the formation of rosaniline.

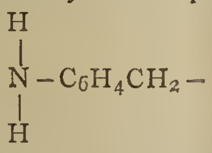
In treating a mixture of one molecule of aniline and two molecules of toluydine with an oxidising or dehydrogenating agent, the lower boiling constituent will be acted upon first, and this is in that case the aniline which by that action loses one of its phenyl nucleus hydrogens, whilst the oxygen is converted into hydroxyl, acting on a fresh molecule in the mixture; and in this case toluydine eliminating one hydrogen of the latter's methylene appendix.

Thus we have a phenylene-amine with a free atomicity, and a toluene-amine with a free atomicity, by which they both combine together, forming the following compound:—



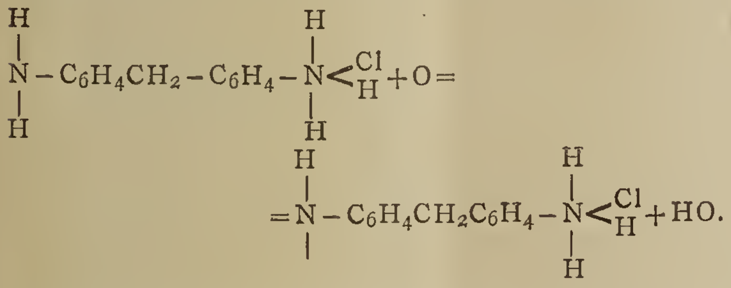
$$ {}^{Cl}_{H}>\underset{H}{\overset{H}{N}}-C_6H_4CH_3+C_6H_5-\underset{H}{\overset{H}{N}}<{}^{Cl}_{H}+O= $$
$$ ={}^{Cl}_{H}>\underset{H}{\overset{H}{N}}-C_6H_4CH_2-C_6H_4-\underset{H}{\overset{H}{N}}<{}^{Cl}_{H}+H_2O. $$

This compound representing an aniline, in which one hydrogen is substituted by the complex—



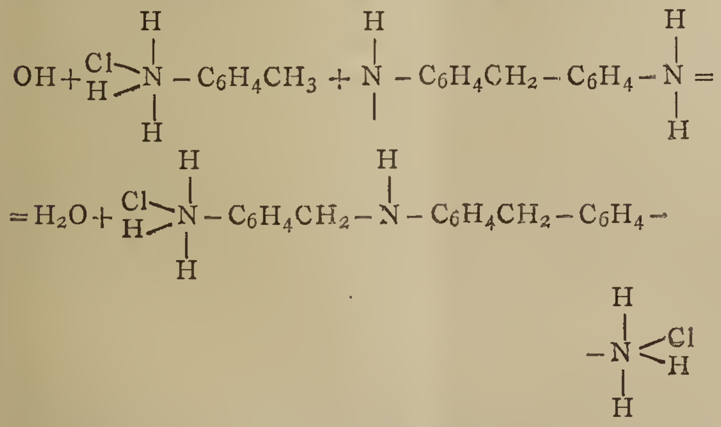
$$ \underset{H}{\overset{H}{N}}-C_6H_4CH_2- $$

can combine only with one acid molecule, and therefore separates with the second one, leaving its nitrogen appendix to the action of oxygen, which latter eliminates one hydrogen.



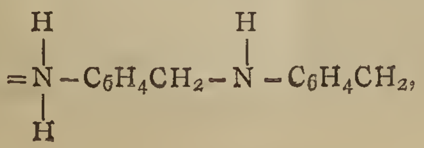
$$ \underset{H}{\overset{H}{N}}-C_6H_4CH_2-C_6H_4-\underset{H}{\overset{H}{N}}<{}^{Cl}_{H}+O= $$
$$ =\underset{|}{\overset{H}{N}}-C_6H_4CH_2C_6H_4-\underset{H}{\overset{H}{N}}<{}^{Cl}_{H}+HO. $$

The hydroxyl coming forth by this process acts on a fresh molecule of toluydine, eliminating one of its methylene hydrogens, by which a free atomicity is produced. By that free atomicity the formed toluene amine hydrochloride combines with the last derivated molecule:—



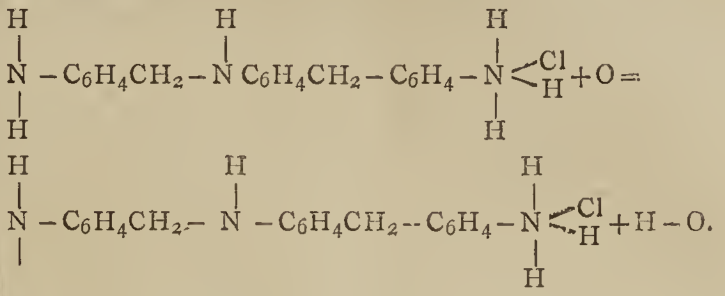
$$ OH+{}^{Cl}_{H}>\underset{H}{\overset{H}{N}}-C_6H_4CH_3+\underset{|}{\overset{H}{N}}-C_6H_4CH_2-C_6H_4-\underset{H}{\overset{H}{N}}= $$
$$ =H_2O+{}^{Cl}_{H}>\underset{H}{\overset{H}{N}}-C_6H_4CH_2-\overset{H}{N}-C_6H_4CH_2-C_6H_4- $$
$$ -\underset{H}{\overset{H}{N}}<{}^{Cl}_{H} $$

The latter complex representing aniline in which one hydrogen is substituted by the complex—



$$ =\underset{H}{\overset{H}{N}}-C_6H_4CH_2-\overset{H}{N}-C_6H_4CH_2, $$

which can combine with only one acid molecule, will separate with its second acid molecule, and thus expose its nitrogen appendix, nearest to that second acid molecule, to the action of a dehydrogenator, which eliminates one of its hydrogens.

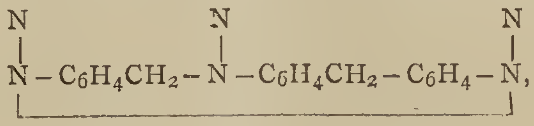


$$ \underset{H}{\overset{H}{N}}-C_6H_4CH_2-\overset{H}{N}C_6H_4CH_2-C_6H_4-\underset{H}{\overset{H}{N}}<{}^{Cl}_{H}+O= $$
$$ \underset{|}{\overset{H}{N}}-C_6H_4CH_2-\overset{H}{N}-C_6H_4CH_2-C_6H_4-\underset{H}{\overset{H}{N}}<{}^{Cl}_{H}+H-O. $$

The group H – O – coming forth in the last reaction acts, as described above, on one of the hydrogens of the nitrogen appendix joined with the acid, and eliminates this hydrogen.

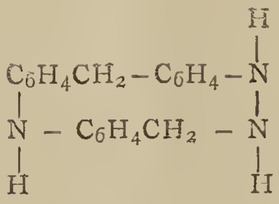
Here, as in the formation of violaniline and mauvaniline, both the nitrogens combine by their free atomicities, and form thus the closed chain representing the structural formula of rosaniline.

In this formula we see that a toluene nucleus is combined directly with a phenylene nucleus, whilst in Liebermann's formula two toluene nuclei are joined together, which is inconsistent wtth the mode of the formation of rosaniline. Libermann's formula would have to be based on the supposition that the higher boiling toluydine is dissociated or acted upon before the much lower boiling aniline, which contradicts experience, and is improbable. Therefore we ought to give the preference to the formula being in conformity with the formation of rosaniline. This formula is—



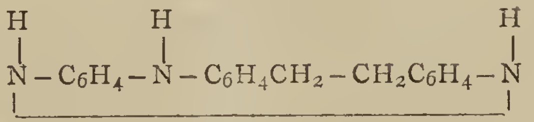
$$ \overset{N}{N}-C_6H_4CH_2-\overset{N}{N}-C_6H_4CH_2-C_6H_4-\overset{N}{N}, $$

Or—



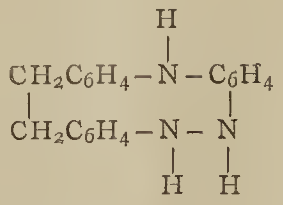
$$ \begin{array}{lcl} & & H \\ C_6H_4CH_2-C_6H_4 & - & N \\ | & & | \\ N-C_6H_4CH_2 & - & N \\ H & & H \end{array} $$

Whilst that of Liebermann is—



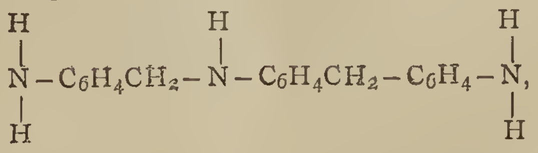
$$ \overset{H}{N}-C_6H_4-\overset{H}{N}-C_6H_4CH_2-CH_2C_6H_4-\overset{H}{N} $$

Or—



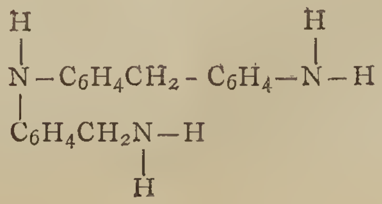
$$ \begin{array}{lcl} & H & \\ CH_2C_6H_4- & N & -C_6H_4 \\ | & & | \\ CH_2C_6H_4- & N & -N \\ & H & H \end{array} $$

According to our formula leucaniline would be—



$$ \underset{H}{\overset{H}{N}}-C_6H_4CH_2-\overset{H}{N}-C_6H_4CH_2-C_6H_4-\underset{H}{\overset{H}{N}}, $$

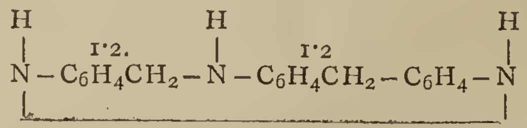
Or—



$$ \begin{array}{l} \overset{H}{N}-C_6H_4CH_2-C_6H_4-\overset{H}{N}-H \\ | \\ C_6H_4CH_2\underset{H}{N}-H \end{array} $$

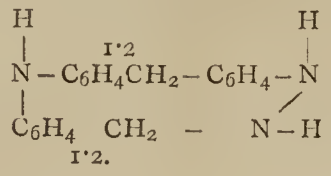
All reactions and decompositions of rosaniline and its salts can be explained as well by this new formula as by that of Liebermann. According to the different isomeric toluydines contained in the commercial aniline for red different isomeric rosanilines will exist.

Rosenstiehl's pseudo-rosaniline, made out of aniline and ortho-toluydine, would be represented by the following formula:—



$$\overset{\text{H}}{\text{N}}-\overset{1\cdot2.}{C_6H_4CH_2}-\overset{\text{H}}{\text{N}}-\overset{1\cdot2}{C_6H_4CH_2}-C_6H_4-\overset{\text{H}}{\text{N}}$$

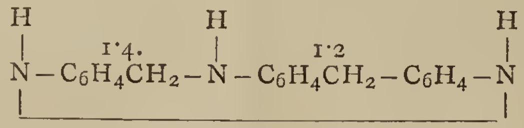
Or—



$$\begin{array}{l} \overset{\text{H}}{\text{N}}-\overset{1\cdot2}{C_6H_4CH_2}-C_6H_4-\overset{\text{H}}{\text{N}} \\ C_6H_4 \quad \underset{1\cdot2.}{CH_2} \quad - \quad N-H \end{array}$$

The commercial aniline for red contains, besides aniline, ortho- and para-toluydine, according to Beilstein and Kuhlberg and Rosenstiehl, both of which will contribute to the formation of rosaniline.

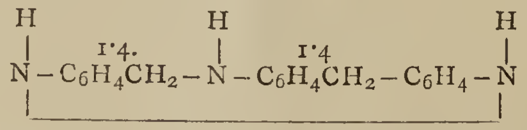
The boiling-point of ortho-toluydine being lower (197°) than that of para-toluydine (198°), the former will be acted upon the first, and therefore joined to the phenylen nucleus, and thus the formula of normal rosaniline will be—



$$\overset{\text{H}}{\text{N}}-\overset{1\cdot4.}{C_6H_4CH_2}-\overset{\text{H}}{\text{N}}-\overset{1\cdot2}{C_6H_4CH_2}-C_6H_4-\overset{\text{H}}{\text{N}}$$

According to Rosenstiehl (*Bull. Soc. Chim.*, [2], xi., 267) commercial magenta contains, in addition to rosaniline, an isomer of it, which he calls para-rosaniline, as it is formed entirely of aniline and para-toluydine.

Para-rosaniline.



$$\overset{\text{H}}{\text{N}}-\overset{1\cdot4.}{C_6H_4CH_2}-\overset{\text{H}}{\text{N}}-\overset{1\cdot4}{C_6H_4CH_2}-C_6H_4-\overset{\text{H}}{\text{N}}$$

There is a possibility of the existence of other rosaniline isomers than those named above, as perhaps those derived from meta toluydine and aniline alone, or combined with the ortho- or para-toluydine, but they are not known at present. As all the aniline in the commercial aniline for red by the rosaniline process is used up for the formation of colouring matters, only toluydine salts remain, causing the formation of chryso-toluydines in a way similar to that of rosaniline, &c., as soon as the boiling-points of the respective toluydines are reached.

The boiling-point of aniline being 182°, that of toluydine say 198°,* then the boiling-point of a mixture of two molecules of aniline and one molecule of toluydine is 188°, and that of a mixture of one molecule of aniline and two molecules of toluydine is 193°. The greater the difference between the boiling-points of such mixture the more decomposition takes place between these boiling-points, and therefore the quantities of the colouring matters produced are proportionate to the respective differences of boiling-points in a judiciously chosen mixture.

Boiling-point of aniline = 182°; of two anilines and one toluydine = 188°; difference = 6.

Boiling-point of one aniline and two toluydines = 193°; difference = 5.

Boiling-point of toluydine = 198°; difference = 5.

If a mixture of 10·5 parts of aniline and 5·5 parts of toluydine would be completely converted into colouring matters by the rosaniline process, a little less than 6 parts of violaniline, 5 parts of mauvaniline, and 5 parts of rosaniline are coming forth. If the proportion of aniline would be greater, a larger quantity of violaniline would be produced, and the yield of rosaniline would then be the less in proportion. If the proportion of toluydine would be greater larger quantities of chryso-toluydines would be produced, lessening the proportions of rosaniline too.

Practically, this process never takes place without formation of chryso-toluydines, the last being produced nearly simultaneously with the last produced quantities of rosaniline.

In the rosaniline process, practically the above-given quantities of aniline are converted completely in the above-given proportions of colouring matters; and thus, if we allow 2 parts more of toluydine for the formation of chrysaniline in addition to the 5½ parts of toluydine, we see that 18 parts of a mixture of 10·5 parts of aniline and 7·5 parts of toluydine will yield nearly 6 parts of violaniline, 5 of mauvaniline, 5 of rosaniline, and 2 of chryso-toluydines, which is the greatest yield of pure and dry rosaniline crystals ever reached in practice.

It is evident that this yield cannot be increased at all, as we cannot alter the boiling-points of aniline and those of toluydines. The nearer the boiling-points are to one another, the more of the mauvaniline and rosaniline would be produced, and the less of violaniline and chryso-toluydines.

100 parts of a mixture of about 60 parts of aniline and 40 of toluydine are converted through the rosaniline process into colouring matters yielding 28 per cent pure and dry rosaniline, which represents 33·6 per cent of magenta crystals, with 7 per cent moisture. This would represent the largest yield of pure magenta crystals which could be reached. The greatest yield ever reached was not quite 33 per cent with arsenic acid, and 32 per cent of pure magenta crystals can be considered as a very good production; whilst with nitro-benzene never a yield over 30 per cent of pure magenta crystals has been attained, the used quantity of nitro-benzene calculated as aniline.

To find the best proportions of aniline and toluydine for the manufacture of magenta, we have to take the above given proportions and add to them an allowance for the quantities of aniline and toluydine which distil over in the rosaniline process, and are recovered also by steaming off the melt. This is a matter of practical experience, and varies according to the size of the charges and other circumstances.

Coupier affirms that by treating his toluydine, which he declares to be a mixture of meta-toluydine (the latter is actually ortho-toluydine) and para-toluydine, with arsenic acid and hydrochloric acid he obtains from 40 to 50 per cent of rosa-toluydine, which is a confirmation of the above-given sentence, that the nearer the boiling-points the higher the yield of rosaniline, or, in that case, rosa-toluydine.

This thorough examination of the rosaniline process has led us to a more probable structural formula of rosaniline, to the explanation of the fact that the yield of rosaniline can never be higher than 30 per cent from 100 aniline for red, and to the respective positions of the nitrogen and methylene appendices in the three isomeric rosanilines known at present.

Adulteration of Geranium Oils.—M. Jaillard.—The author detects fatty oils, gum resins, and other liquid hydrocarbons as follows:—Into a test-glass are poured 5 c.c. alcohol at 70 per cent, and 6 drops of the oil in question, and the whole is well shaken up. If the oil is pure it remains bright and clear, while sophisticated specimens turn milky. This process is of course not available for the detection of cheaper ethereal oils.—*Wochenschrift Oel und Fett Handel.*

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* The three different toluydines have three different boiling-points; 198° may be considered to be the average.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, April 15, 1879.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., President, in the Chair.

"*Mineralogical Notes*," by Charles A. Burghardt, Ph.D., The Owens College.

Precious Garnet (Almandine) from Ramsbottom, Lancashire.

A few days ago I received a small specimen of rock from a former pupil of mine (Mr. J. F. C. Sieber), accompanied by a note, in which the writer gave particulars respecting the locality in which the rock was found, and asked me to examine certain red granules present in the rock in order to ascertain whether they were garnets or not. The rock itself is a conglomerate of milky quartz grains (varying considerably in size), cemented together with silica and calcium carbonate; and disseminated throughout this conglomerate are the garnet grains in question, the whole constituting a 14-feet "fault" in the coal seam known as the Sand-rock or Featheredge Seam in the "Shipperbottom Mine," near Grant's tower at Ramsbottom. The coal from this mine is accompanied by a shale, which contains a very considerable amount of sulphate of aluminium, as it effloresces on being exposed to the action of the air; becoming eventually perfectly white like a piece of chalk. A microscopical examination of the rock showed the garnets to be very irregular in form and to vary considerably in size, the largest attaining a width of about 2·25 m.m., and the smallest about 0·75 m.m. They exhibited no distinct crystalline form, but a peculiar indented appearance was observed on the surfaces of some individuals, whilst others were pebble-like, somewhat convex, and rounded off as though they had been mechanically acted upon by water. The quartz grains did not exhibit the slightest trace of crystalline form, but were rounded off, and pebble-like. Both the garnets and the quartz grains could be extracted from the matrix, a cast of their forms being left behind. The red grains fused easily and quietly before the blowpipe to a black bead, which was not, however, magnetic: they were somewhat attacked by hydrochloric acid, with a slight separation of powdery silica; the presence of iron was also detected. The hardness of the mineral was 7·5, and its specific gravity 4·09 at 9° C. I hope shortly to determine the chemical composition. A microscopical examination of the garnet grains showed them to be crystalline, exhibiting certain marked peculiarities, and after a careful examination of many of them I came to the conclusion that the form in which they crystallised was the rhombic dodecahedron. I had previously proved them to be crystals of the regular system by examining the grains in polarised light and finding them to be isotropic. The crystals were built up out of myriads of minute laminated abnormal rhombic dodecahedrons, two faces of which have been enormously developed at the expense of the other faces. These laminæ are arranged parallel with each other in positions corresponding to each face of a rhombic dodecahedron, the indentations observed upon the indistinct crystal faces of some individuals being caused by this peculiar laminated growth. The laminæ vary from 0·0282 m.m. to 0·1880 m.m. in length, from 0·0188 m.m. to 0·1504 m.m. in width, and from 0·0031 m.m. to 0·0045 m.m. in thickness. The colour of the garnets (for such the crystals undoubtedly are) is light rose-red, and coupling this with their transparency and chemical properties there can be no doubt that they are alumina-iron garnets, or *almandine*. On examining some of the laminæ under the microscope I observed that they contain enclosures, which were mostly fluid cavities or "gas-pores," also here and there cracks and rifts, filled with a white substance, which most probably was calcite. On some of the laminæ there was a separation out of a greenish mossy substance, which I believe to be ferric oxide, and on one individual I observed a few specks of iron pyrites. It is somewhat difficult to draw a conclusion as to the origin of these garnets in such a locality. From the microscopical examination of the rock it would appear that the cement and the garnets were *both* in a soft and pasty condition, the latter being probably formed whilst in the pasty matrix and prevented from attaining a normal development. It is a well-known fact that crystals which have formed in a free space or in a liquid mass, which has not exerted any retarding influence upon the force of crystallisation, always exhibit well defined faces and angles, whilst the opposite conditions result in abnormal growths such as the garnet crystals just referred to. The quartz grains were probably formed previously to the garnets, as they appear to be waterworn pebbles, and were most likely carried along with the semi-paste like mass which contained the constituents of garnet and calcite in its substance. When the paste hardened, the quartz grains and the garnets were enclosed in the manner exhibited on the specimen of rock from Ramsbottom. All the constituents of garnet were at hand, namely, aluminous shale, which would furnish the alumina and silica, and iron pyrites, which would furnish the iron, whilst water impregnated with calcium carbonate, acting upon the shale and iron pyrites, would bring about the necessary chemical changes, calcium sulphate being formed and carried away, and the garnet solution (if such a term may be used) could then crystallise out. From the formation and the locality in which the garnets were found it is quite certain that their origin was aqueous. Another explanation of the occurrence of garnet in the conglomerate may be as follows, viz.:—Garnet is a very common accessory of crystalline rocks, occurring mostly in slates of various kinds, such as talc slate, mica slate, chloritic slate, and aluminous slate; it also occurs in gneiss, granite, porphyry, serpentine, and granular limestone. One or more of the above-mentioned rocks containing crystallised garnets already formed were disintegrated by the action of water, and the resulting *débris* (consisting of grains or pebbles of quartz and garnets) was carried away and deposited in a semi-fluid mass of silica and calcite, and thus cemented together. The question which next arises is, where and what is the original garnet rock in the neighbourhood of Ramsbottom? is it perhaps the aluminous shale? This problem still remains to be worked out. It is evident, however, at once on examining the conglomerate that there is a large excess of quartz grains present, with a very fair sprinkling of garnets; whilst the cement is not present in any great amount. An examination of thin sections of this rock under the microscope may clear up some doubts and throw further light upon its origin.

Fibrous Rock-salt (Sodium Chloride).

This anomalous formation has always been an interesting one on account of the strong cubical "habit" of rock-salt, all other forms than that of a well-defined cube being rarities. The fibrous formation is not due to a crystallisation of the sodium chloride in another system than the regular system, but is explained by an abnormal development of four cubical faces parallel to one axis, which may with propriety be called the prismatic axis. So far as I am aware, the formation of fibrous rock-salt has not been explained. Having the well-known fact before me, viz., "the influence exerted upon the crystal form of a body crystallising out of its solution by the presence in that solution of a small quantity of a foreign body," I thought it probable that a similar effect might be produced upon the growth of sodium chloride crystals by the presence of a foreign body or bodies. In order to ascertain this I made a strong saturated solution of ordinary table-salt, filtered it, and precipitated out most of the salt by passing hydrochloric acid gas into the solution. The liquid was drained off from the precipitated salt, and allowed to evaporate *very slowly* for several days in a narrow necked flask, and then laid aside to cool. I then observed amongst the mass of ordinary salt numerous long well-developed prisms. Some of these prisms were an inch or more in length, and sometimes terminated by a broad cube. Others, again, were twinned according to the usual law, viz., "the twin plane a face of the octahedron." I observed that many of the cubical crystals were somewhat bent, and resembled closely the bent barytes crystals of the prism and basal terminal plane in combination. Nearly all the crystals (prismatic and cubical) were opaque or almost so, and of a very white colour. In addition to free hydrochloric acid, I found in the solution a quantity of magnesium sulphate and magnesium chloride, and it is to the peculiar retarding action of these substances, either together or singly, that I ascribe the general formation of fibrous rock-salt; for they could easily occur *naturally* in any rock-salt formation. As sulphate of magnesium and chloride of magnesium are constituents of sea-water, and generally present in all waters flowing from rocks, either crystalline or sedimentary, their presence during the deposition of rock-salt is ensured, whilst the presence of hydrochloric acid would also be possible if a slight rise of temperature took place during the deposition, it being a fact that magnesium chloride gives off hydrochloric acid during evaporation at comparatively low temperatures.

In the discussion which followed the reading of the above paper Mr. Binney, F.R.S., read an extract from *Trans. Man. Geol. Soc.*, vol. i., p. 87, to the following effect, viz.:—

"'*On the Marine Shells found in the Lancashire Coal Fields*,' by E. W. Binney.

"Immediately above the 'Rough rock' at Birtle Dean, near Heywood, is the Featheredge coal, about two feet thick; this seam has a roof of one yard in thickness, consisting of black shale which is full of the Pecten, Goniatites, Povidonia, &c., mixed with various species of Ferns, Lepidodendra, and Sigillariæ. It is a singular fact that the black shale has scarcely ever been seen on the roof of this coal, except at Messrs. Ramsbottom's Colliery, at Birtle Dean. At Fecit, within two miles of the last named place, and other localities, the roof of the coal consists of a coarse conglomerate of quartz pebbles, containing numerous garnets and crystals of carbonate of barytes, generally presenting a water-worn appearance. I have also observed small pieces of opal imbedded in this rock."

NOTICES OF BOOKS.

Science Teachings in Living Nature. A Popular Introduction to the Study of Physiological Chemistry and Sanitary Science. By W. H. Watson, F.C.S., F.M.S. London: E. Stanford.

This book labours under the disadvantage of being, to a very great extent, an *Ileas post Homerum.* Had it appeared prior to such well-known and popular treatises as Johnston's "Chemistry of Daily Life," Lewes's "Physiology of Daily Life," and others which might be mentioned, it would have achieved and deserved a great success. As the case actually stands, however, containing little either in facts or in conclusions which may not be found in the works just referred to, we fear it will be regarded as anticipated.

Although the author's teachings are upon the whole in accordance with what is regarded as demonstrated, there are a few cases where we find statements either questionable in themselves or capable of being misunderstood by the unscientific reader, for whom the book is avowedly compiled.

Thus in the Introduction (p. x.) we are told that "the brains of the wise . . . are explained by the necessary application of chemical science." This sentence may convey the impression that chemistry has succeeded in throwing a light upon the connection between intelligence and that part which we assume to be its organ, and in discovering a difference in composition or molecular arrangement between the brain of the wise and of the unwise. Mr. Watson must be well aware that no such explanation has been given, and that the manner in which the brain subserves the action of the reasoning principle within us is scarcely less a mystery to us than it was to our rudest forefathers.

On page 9 the author contends—as was at one time very generally believed, and as is still held by General Pleasanton and his followers—that "the value of light in relation to life depends, up to a certain point, upon the amount of the blue and violet rays which it contains." This view is not in harmony with the results of more recent observations, nor does it agree with certain conclusions quoted by the author on a subsequent page.

In the outset of Chapter II. Mr. Watson seems to adhere to the old supposition, now abandoned, that the respiratory process in plants and in animals is essentially different and opposite. Thus he writes:—"Fungi are a peculiar exception to this rule, for their breathing functions resemble those of animals rather than those of plants." It is now known—see, *e.g.*, Prof. Allman's Presidential Address at Sheffield—that the respiration, strictly so-called, of animals and plants is identical, oxygen being in each case absorbed and carbonic acid evolved. In plants, however, during daylight, the respiratory process is masked by the much more active process of nutrition, in which carbonic acid is decomposed, its carbon assimilated, and its oxygen liberated. Mr. Watson is doubtless aware of this distinction between vegetable respiration and nutrition, and of the identity of the breathing process in the two great organic kingdoms; but we fear that the reader will fail to find it in his pages.

On page 67 we read—"It has been well said that a bad theory is worse than none at all." With this *dictum* we can agree only to a very limited extent. Even a bad theory gives a definite character, which might otherwise be wanting. The mischief begins when men ignore or garble facts which cannot be made to chime in with their theories. The doctrine of phlogiston—which, by the way, was not held in ancient times—was useful in the earlier part of its existence.

Turning over the leaf we come upon a passage which we must beg to quote:—"Lavoisier, whose history is perhaps the most noteworthy of any philosopher either before or since, was put to death owing to the scientific opinions which he held; and looking through the histories of science generally, I think we cannot fail to notice that religion has from very early times been a damper to the progress of science."

We certainly never before heard it insinuated that any of Lavoisier's scientific opinions were objected to by the heads of the Revolution. The charge on which he was arraigned and condemned was that, in his capacity of *Fermier-Général*, he had connived at the adulteration of certain tobacco. The judges certainly declared that "the Republic had no need of chemists," but this by no means bears out Mr. Watson's assertion. However this may be, anyone reading the sentence we have quoted can scarcely avoid inferring that Lavoisier's persecutors were ecclesiastics, or were actuated by a religious motive, whilst in point of fact they were mainly atheists! We admit that "scientific savans," as Mr. Watson calls them, have been oppressed by "clericals." But we think the future enemies of Science must be sought elsewhere. Let it once be understood that she has no word of cheer for those who would thrust God out of the universe, and that her teachings—contrary to the vain fears of Virchow—are hostile to "social democracy," she will find enemies who merely wait their opportunity.

Towards the end of the work we are told that "most of our large towns are now supplied [with water] from the Lake Districts." This assertion deals probably with the future rather than the present.

We should suggest to Mr. Watson a reconsideration of the passages to which we have called attention.

Lectures on the Theory and Control of Infectious Diseases. By Jas. B. Russell, M.D., Medical Officer of Health. And on *Air, Water Supply, Sewage Disposal, and Food.* By W. Wallace, Ph.D., F.C.S., City Analyst. Glasgow: Maclehose. London: Hamilton, Adams, and Co.

It has often been remarked that the number of chemical manuals produced in this country is out of all fair proportion to our yield of chemical research. In like manner it might be said that the progress of rational measures for the promotion of public health has been scarcely in accordance with the number of sanitary treatises, lectures, and speeches with which we are favoured. Indeed—save among those whose official duties compel them to labour, in season and out of season, at the repression of infectious disease, and, on the other hand, among the more favoured few to whom sanitary movements have brought emolument and celebrity—the interest in the subject is perceptibly declining. Ten years ago, for instance, the disposal of sewage was often eagerly and intelligently discussed among persons casually meeting, *e.g.*, in public conveyances. This excitement has died out, and the average John Bull is perhaps a little too ready to pronounce the various systems of sewage-treatment to be mere costly humbugs; sport, possibly, to engineers, but death to the rate-payer. That the lectures before us contain a great amount of interesting matter, the names of its authors will be a sufficient guarantee. Of the many passages which might claim especial comment, space will permit the notice of a few only. Thus in a quotation from Dr. Farr, with which Dr. Russell's first lecture opens, we find it mentioned that "they"—*i.e.*, infectious diseases—"take the lives of criminals that justice has not condemned." Surely in so far these diseases render a great service to society, and save justice much trouble. On the important subject of density of population as affecting mortality, we find the persons per square mile in the Manchester District given as 12,357, and in the Liverpool District 65,823. Yet this fivefold increase of the density of population merely raises the death-rate from 38 per thousand in the former case to 39 in the latter.

Dr. Alison's painful story of the spread of typhus fever, quaintly presented by Thomas Carlyle,* is no doubt a striking reply to those who look with apathy upon disease among the poor. But it has yet a further lesson: if community of disease proves kindred, how can we still maintain the old myth of the total and essential distinction between man and the lower animals?

Dr. Russell contends, and in our opinion with perfect justice, that poor-law administrators and poor-law officials are essentially unfitted for the successful performance of the functions of a local authority under the Public Health Act.

The importance of vaccination is ably pleaded, but the difficult question still remains unsolved: how is it that now this supposed safeguard is all but universal, we have still small-pox epidemics, whilst in the earlier part of the century (say about 1830), when vaccination was optional, and was rare save among the more cultivated classes, the disease seemed to have vanished, and was spoken of as a thing of the past?

Dr. Wallace, in his comparison between the respective production of smoke in Glasgow and in London, overlooks the great distinction that Glasgow is essentially a manufacturing town, whilst London carries on manufactures only to a very subsidiary extent. A law empowering the magistrates in Glasgow, Leeds, &c., to order the closing of works which cannot be conducted without the emission of smoke would be, in our opinion, a most rash and impolitic measure. The lecturer complains that "avarice" entails upon us "narrow streets, built up lanes, and every foot of ground converted into money." But if we insist upon wider streets the same avarice will charge proportionately higher ground-rents.

We cannot admit that "both the mechanical and dissolved impurities of water" are excluded on freezing. We have repeatedly seen ice in which sticks, straws, vegetable fibre, and particles of excrementitious matter have become imbedded.

We are very glad to see a protest against the sensational system of describing all matters present in water, save oxygen and hydrogen, summed up as "total solid impurity." It misleads the public. From the abstract chemical point of view small quantities of carbonate of lime, &c., may doubtless be regarded as impurities. But when we are considering a drinking water, from a dietetic point of view, the case is different. That absolute H_2O would be a salutary beverage is a totally unproved assumption.

The author's remarks on the various systems of sewage-treatment are not reassuring. Without entering upon a controversy, we will merely express the wish that he would have considered some of the evidence by which certain of the conclusions of the Rivers' Pollution Commissioners have been so superabundantly refuted.

In the interesting lecture on food Dr. Wallace remarks that the "only materials" used in baking bread are flour, water, yeast, and salt. In London he would be told by anyone connected with the trade, that he had forgotten that legalised adulteration, the potatoes.

We trust that these courses of lectures may have had a beneficial effect, as we have heard it contended in Glasgow—and that by one of its citizens of no mean standing—that all the impurities of the Clyde and the Kelvin, and all the contaminations of the air, had wrought no harm to the health or the longevity of the inhabitants.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 11, September 15, 1879.

On Woollen Cloths Dyed a Blackish Blue in order to Replace the Indigo-blue used in the Uniforms of the French Army.—E. Chevreul.—The author shows that the colouring-matter of the cloth in question cannot be indigotin, Prussian blue, or ultramarine, but that it may be one of the aniline dyes.

Experiments tending to show the Compound Nature of Phosphorus.—Letter from Mr. N. Lockyer to M. Dumas.—Phosphorus heated in a tube with copper gives a very brilliant hydrogen spectrum. Phosphorus alone, heated in a tube where a vacuum has been formed by Sprengel's apparatus, gives nothing. Phosphorus, at the negative pole in a similar tube, gives very abundantly a gas which shows the spectrum of hydrogen, but which is not hydrogen phosphide.

Determination of Organic Nitrogen in Natural Waters.—H. Pellet.—For the determination of ammoniacal nitrogen the author follows the directions of Boussingault. For the nitric nitrogen he evaporates 3 litres of water, and when the residue amounts merely to 60 or 80 c.c., he adds acetic acid to decompose the carbonates without attacking the nitrates. The whole is heated to a boil and the volume is made up to 100 or 200 c.c., according to the deposit. He then filters and determines the nitric nitrogen in 25 or 50 c.c. of the liquid according to Schlœsing's method, measuring the binoxide of nitrogen produced. For the total nitrogen he likewise

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* "Past and Present," Book III., Chap. .

evaporates 3 litres of water in contact with 2 grms. of pure magnesia to drive off the ammoniacal nitrogen. A part of the dry residue is mixed with soda-starch and introduced into a combustion-tube. By this addition of carbonaceous and hydrogenous matter all the nitric nitrogen passes into the state of ammonia, and the operation becomes an ordinary determination of nitrogen by the soda-lime process. The quantity of nitrates present, however, should not be greater than 0·20 or 0·25 grm. of nitrate of potassa. This is the reason for the previous separate determination of the nitric nitrogen.

Oxidising Action of Cupric Oxide: Transformation of Acetic Acid into Glycolic Acid.—P. Cazeneuve.—10 grms. acetate of copper, powdered and mixed with 25 grms. of water, were heated for an hour to 200° in a sealed tube. The tube contains a deposit of cuprous oxide in crystals, apparently of a special form. On opening the tube a little carbonic acid escaped, and the filtrate, on evaporation in a vacuum at a temperature not exceeding 50°, deposited blue crystals, which prove to be glycolate of copper. By an analogous reaction the propionic acid may be transformed into the lactic.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin,
No. 8, 1879.

Oxidation of Cinchonin-chinolin by Potassium Permanganate.—W. Kœnigs.—The author is attempting to break up the benzol ring of chinolin by the oxidation of this base or of amido-chinolin, in the hope of thus forming a phthalic acid of pyridin.

Piperidin and Pyridin.—A. W. Hofmann.—The author has examined the action of bromine upon piperidin, obtaining a compound $C_5H_3Br_2NO$, with its platinum-silver and methyl combinations. Pyridin has likewise been treated with bromine, the result being dibrom-pyridin.

Angelyl Mustard Oil.—A. W. Hofmann.—The compound obtained, C_6H_9NS, is a higher homologue of crotonyl oil of mustard.

Umbelliferon and some of its Derivatives.—F. Tiemann and C. L. Reimer.—The authors prove that umbelliferon is an oxy-cumarin derived from resorcin.

Aldehyds from Orcin and their Derivatives.—F. Tiemann and E. Helkenberg.—The compounds described are orcyl-aldehyd, orcyl-aldehyd-anilid, homo-acetoxy-cumarin, α-orcendialdehyd, α-orcendialdehyd-dianilid, and β-orcendialdehyd.

Tribrom-phenol-brom and Tribrom-resorcin-brom.—R. Benedikt.—The former of these bodies is formed on the exhaustive bromation of many aromatic oxy-acids. The penta-brom-resorcin of Stenhouse and the tribrom-resequinon-bromide of Liebermann is probably tribrom-resorcin-brom.

Fractionated Combustion of Hydrogen and Marsh-Gas.—W. Hempel.—A mixture of hydrogen with excess of oxygen, passed over palladium burns completely. The reaction begins at common temperatures, the palladium becomes red hot, and an explosion follows if the gases are present in a suitable proportion. Marsh-gas with oxygen, passed over palladium, burns at about 200°. Mixtures of hydrogen, marsh-gas, and oxygen, if in the proper proportion, detonate violently. In such mixtures, when the oxygen is in excess, the hydrogen alone burns if the external temperature does not exceed the marsh-gas remaining unattacked, provided the palladium is prevented from becoming too hot.

On Nitro-alizarin.—E. Schunck and H. Rœmer.—The authors find that their method of nutrition (*Berichte*, xii., p. 584) had been already made known by Caro.

A Homologue of Phosphenyl-chloride.—A. Michaelis.—Along with phosphenyl-chloride the author has obtained a homologue of the composition $C_7H_7PCl_2$.

Reply to the Remarks of E. and O. Fischer.—O. Dœbner.—A continuation of the "malachite green" controversy.

Biedermann's Central-blatt für Agrikultur-Chemie.
September, 1879.

Researches on the Proportion of Carbonic Acid in the Atmosphere.—J. Reiset.—Taken from the *Comptes Rendus* and already noticed.

Investigations on Spongy Iron and Animal Charcoal as Agents for the Purification of Water.—Dr. L. Lewin.—A perfect filtering material should be able to remove not merely suspended bodies, but such as are in states of physical and chemical combination, and either retain them in such a manner that the subsequent application of pure, or at least purer, waters may be unable to wash them out, or else to transform them into a condition in which they can no longer interfere with the quality of the water. In addition a filter must retain these powers unimpaired for a length of time. The attempts which have been made to imitate the processes of nature by passing the river water used for the supply of large towns through deep beds of sand and gravel have shown that such a process has no claim to be regarded as chemical. The case is differerent when charcoal, and especially animal charcoal, is used as filtering material. The latter not only holds back colouring-matters and decomposes or partially retains most mineral salts and gases, but it absorbs and detains the most varied organic compounds, nitrogenous as well as non-nitrogenous. Particularly important is its power—first demonstrated by Claude Bernard, and confirmed by other inquirers—of absorbing albumen, a power which increases with the quantity of the latter, with the time of contact, and with the concentration of the liquid to be filtered, and which is the more important as the arrested body is held so firmly as not to be removed by solvents. This valuable material has also its shortcomings, which especially consist in its ready saturation with impurities so that it needs to be revived, *i.e.*, freed from the detained matters, or if this is impracticable, to be renewed altogether. Other substances have therefore been suggested as substitutes for charcoal, and amongst others various modifications of iron, especially spongy iron. The latter substance has been submitted by the author to an elaborate experimental examination. His experiments show that as regards nitrogenous substances the spongy iron filter is inactive. Such substances are neither decomposed nor held back in such a manner as not to be readily washed out again. It can be stated with the fullest certainty that if only 10 c.c. of urine containing moving bacteria are mixed with 2 litres of water, and passed through the spongy iron filter, numerous bacteria can be detected in the filtrate. The odour of putrescent matter is but very slightly removed by spongy iron. The alleged improvement undergone by plumbiferous waters in contact with spongy iron were found to be insignificant.—*Zeitschrift fur Biologie*, 1878, No. 4, pp. 483—506.

A Contribution to the Chemistry of Starch.—Dr. V. Griessmayer.—The following transformation products originate on the action of diastase or of dilute sulphuric acid upon starch:—(1.) Soluble starch, insoluble in water of from 50° to 60°; in the solid state it is coloured by iodine blue, but in an aqueous solution a vinous red, and if dried up with an excess of iodine it becomes violet, yellow, or brown. (2.) Erythrodextrin, which is chiefly met with in commercial dextrin; it is never insoluble in water, and is coloured red by iodine, both in the solid state and in solution. (3.) The achroodextrins, α, β, and γ, which take no colour with iodine. α can be partially converted into sugar, but less easily than 1 and 2. β resists the action of diastase for twenty-four hours at least. γ is not attacked by diastase for a year at least. (4.) Maltose, not readily attacked by diastase. (5.) Glucose.

The author considers starch as a poly saccharide of the formula $n(C_{12}H_{20}O_{10})$, in which n must be first determined, but cannot be less than 5 or 6.

La Correspondance Scientifique.

September, 1879.

This issue contains the presidential discourse of M. Bardoux, delivered at the Montpellier meeting of the French Association for the Advancement of Science. Among the papers read before the Chemical and Physical Sections were:—On the Compound Ammonias, by M. Buisine; on the Oxidising Action of Cupric Oxide, by M. Cazeneuve; on the Determination of Methylic Alcohol in Ethylic Alcohol, by M. Caillol; on the Calcareous Soils of Barcelona from a Chemical Point of View, by M. Luis Cabello e Ibanez; on the Emissive and Absorbent Powers of Flames, by M. Rosetti; on a Compass for the Measurement of Powerful Currents, by M. Ducrétet; Method of Measuring the Intensities of the Currents of Bunsen Batteries by Means of Thomson's Galvanometer, by M. Mercadier; and on Thermometric Measurements of High Temperatures, by M. Crova. The "compass" of M. Ducrétet is a modification of the well-known instrument of Pouillet. The vertical circle receives a different arrangement, and instead of being fixed perpendicularly it is mounted at its centre by a system of pivots, which traverse it in the direction of its diameter. Hence it becomes possible to give it all positions comprised between the vertical and the horizontal.

Chemiker Zeitung.

No. 33, August 14, 1879.

The German Imperial Public Health Department is said to be preparing measures for the repression of secret and proprietory remedies.

Determination of Sugar in Beet-root.—Dr. Scheibler.—It has been falsely assumed that all the liquid in the root contains water. The author shows that in addition to the saccharine sap there exists in the beet non-saccharine water, chemically combined with the solids.—*Arch. Pharm.*

No. 34, 1879.

In Switzerland the sale of patent and secret medicines is about to be submitted to very stringent regulations.

Lute for Distillatory Apparatus.—Thanisch, instead of linseed-meal, proposes strips of brown paper smeared over with book-binders' paste to which one-eighth of glycerin has been added.

No. 35, 1879.

Chemical Purification of Waste Waters.—Jean de Mollins.—The author, who has dealt with the waste waters from the woollen mills of Roubaix, recommends milk of lime and sulphate of alumina, together or separately. He considers that the action of the aluminous hydrate upon the organic impurities of water is quite analogous to its behaviour with dissolved colouring-matters which it throws down in the form of lakes. He also points out that clay, if diffused in water, becomes coagulated by the presence of certain salts, and carries the organic impurities down with it.

New Method of Producing Varnish.—Dr. E. Schrader.—The author causes ozone to act upon linseed oil, which is at once perfectly bleached and brought to the proper consistence without the aid of fire.

Quantitative Determination of Tannin.—Dr. Ostermayer.—The author proposes the following modification of Wagner's process. 10 grms. of the substance are completely exhausted with hot water; the liquid filtered when cold, and evaporated to dryness. The residue is extracted with a mixture of 1 part ether and 2 parts alcohol at 90 per cent as long as tannin is taken up. The extracts are united, again evaporated to dryness, and the residue dissolved in 500 c.c. water. The solution is almost colourless. 50 c.c. of this solution are titrated with a solution of cinchonin coloured with magenta, till the liquid begins to retain the colour of the latter. Every c.c. of cinchonin solution consumed corresponds to 1 per cent of tannin. To prepare the cinchonin solution 4·523 grms. of cinchonin sulphate, 0·1 grm. magenta, and and 0·05 grm. sulphuric acid are dissolved in water and made up to 1 litre.—*Pharm. Zeitung.*

Iodine-starch Reaction.—E. Heintz.—The author shows that tannin is among the substances which can prevent the appearance of this reaction.—*Pharm. Zeitung.*

Reaction for Salicylic Acid.—H. Schulz.—If an aqueous solution of salicylic acid or sodium salicylate is mixed with a little solution of copper sulphate a bright emerald green colour appears, perceptible if 1 part of the sodium salt is dissolved in 2000 parts of water. The addition of a stronger acid, or of ammonia, destroys the green colour.—*Pharm. Zeitung.*

Distribution of Arsenic in the Organism after Ingestion of Arsenious Acid.—Prof. E. Ludwig, after the examination of many cases, both of acute and chronic poisoning, finds the arsenic chiefly collected in the liver, very little being retained in the brain and the bones. This conclusion is directly opposite to that of Scolosuboff, who always found most arsenic in the brain.—*Akad. Wissensch. Wien.*

Occurrence of Algæ in Saline Solutions.—A. Tschirch makes the interesting observation that in almost all bottles of magnesium sulphate, and in some of calcium sulphate solutions, in the laboratory of Berlin University, algæ have made their appearance. They are Palmellaceæ and develop chlorophyll.

No. 36, 1879.

This issue opens with a short biographical notice of Berzelius, the centenary of whose birthday was celebrated on August 29.

A serious explosion took place on August 15 in an oil and colour warehouse in Vienna, in consequence of a carboy of benzin being decanted in the proximity of a naked flame. The proprietor and three assistants are dead from the wounds received.

The Alps and the Jura are being diligenly searched by gold hunters. Certain English speculators have purchased and re-opened a mine in the Grisons, locally known as "Die Goldene Sonne."

Dr. Brauns, of Halle, has been appointed to the chair of mineralogy and palæontology in the University of Tokio, Japan.

MISCELLANEOUS.

University College, London.—A special Practical Course of instruction has been arranged to meet the requirements of Students who are preparing for State Medicine Examinations, or who wish to become Public Analysts. It will consist of two parts, and will require daily work for four months. It may be commenced at any time during the Session, from October to July. The State Medicine Department is under the direction of Professor Corfield, M.A., M.D.; Mr. C. E. Cassal, F.C.S. being demonstrator in the Hygienic Laboratory.

University College, Bristol.—In addition to the Courses of Lectures and Laboratory instruction referred to in our Students' Number arrangements have been made for a special Course, by Professor Letts, on Metallurgy, explaining the method of extraction, purification, &c., of the useful metals, and the properties upon which their utility depends. The fee for two terms is two guineas.

COMPOSITION AND QUALITY OF THE METROPOLITAN WATER.

SEPTEMBER, 1879.

THE following are the returns of the Society of Medical Officers of Health:—

	Appearance in 2 foot Tube.	Ammonia.		Nitrogen as Nitrates, &c.	Oxygen used to Oxidise Organic Matter.	Total Solids.	Lime.	Magnesia	Chlorine	Sulphuric Anhydride.	Hardness on Clark's Scale	
		Saline.	Organic.								Before Boiling.	After Boiling.
		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Degrees	
Thames Water Companies.												
Grand Junction	Clear	0·000	0·009	0·126	0·148	20·00	7·750	0·504	1·008	1·133	14·1	3·6
West Middlesex	Clear	0·000	0·010	0·106	0·159	20·40	7·590	0·432	1·008	1·133	14·1	3·3
Southwark and Vauxhall	Clear	0·000	0·009	0·105	0·155	20·20	7·160	0·460	1·080	1·330	13·2	3·7
Chelsea	Clear	0·000	0·009	0·108	0·089	20·00	7·630	0·432	1·152	1·330	15·2	4·6
Lambeth	Clear	0·000	0·011	0·020	0·148	20·70	7·340	0·496	1·080	1·630	14·7	3·3
Other Companies.												
Kent	Clear	0·000	0·001	0·390	0·014	26·70	7·460	0·632	1·800	1·660	18·8	6·5
New River	Clear	0·000	0·004	0·132	0·094	20·70	7·400	0·576	1·080	1 630	13·7	3·3
East London	Clear	0·000	0·009	0·126	0·062	20·80	7·160	0·432	1·152	1·300	13·2	3·7

The quantities of the several constituents are stated in grains per imperial gallon.

NOTE.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

C. MEYMOTT TIDY, M.B.

TO CORRESPONDENTS.

J. A.—The books named give full information.
H. V.—Auerbach is probably right.

NOTES AND QUERIES.

Pyrites in Manufacture of Sulphuric Acid.—Could any of your readers inform me which is the cheapest way of using up smalls of pyrites in the manufacture of sulphuric acid?—"SULPHUR."

Analysis of Cinchona Bark for Alkaloids.—Can any of your readers inform me what are the detals of the process, or where the process may be found, for the complete analysis of cinchona bark for alkaloids as followed by London quinologists?—L.

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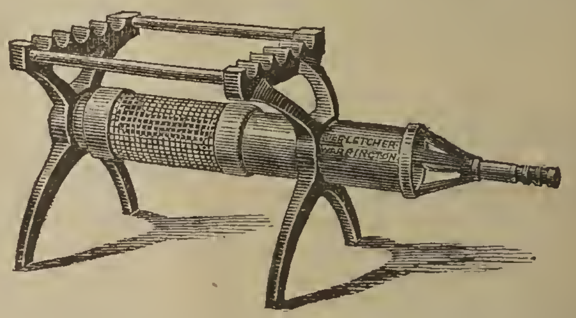

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THE CHEMICAL NEWS.

Vol. XL. No. 1038.

THE EUCALYPTUS AND THE PINE CONSIDERED IN RELATION TO THEIR SANITARY PROPERTIES.*

By C. T. KINGZETT, F.C.S., F.I.C.

As is widely known, both the eucalyptus and the pine have long enjoyed a popular reputation as health agents. In particular the eucalyptus has acquired the character of the "fever-destroying tree," and has been largely cultivated in various parts of the world with the view of rendering habitable large districts previously devastated and depopulated by malaria, &c. In this paper, the author, referring to the old theory of the action of the eucalyptus, which attributes its sanitary powers to its drainage properties, shows that this hypothesis always lacked evidence, and at its best was of a negative character. In the first place, the eucalyptus is only superior to other trees as a means of drainage in the proportion in which its rate of growth exceeds that of other trees, and this is not sufficiently notable to account for its extraordinary fever-destroying properties. Then, again, other trees, even if planted in malarial districts do not free them from the disease, so that the *action* of the eucalyptus is of a positive type, and, like the pine tree, its properties are of a healthful nature, upon whatever soil or in whatever climate it may grow, whether in deep valleys or upon the sides of mountains. Others have maintained that just as pine forests are supposed to exert their beneficial influence upon persons suffering from pulmonary and other affections, by virtue of the volatile emanations arising from them, so the eucalyptus produces its well-known effects by the oil which is evaporated from its leaves. Mr. Kingzett then examines this hypothesis in detail, and shows the relative oil-yielding power of the different species of eucalyptus. The genus embraces over 130 species, and of these *Eucalyptus amygdalina* is the most abundant oil-giving tree; 100 lbs. of the leaves giving from 3 to 6 lbs. of the oil. This oil is practically identical in composition with the oil of turpentine derived from pine trees, and with most of the so-called essential oils or perfumes. By the investigations of Mr. Kingzett, it has been ascertained that all these oils when subjected to the action of atmospheric oxygen and moisture produce peroxide of hydrogen and a number of camphoraceous substances having marked antiseptic powers. Knowing, then, how much of these substances are yielded in the laboratory by a given quantity of oil of eucalyptus or oil of turpentine, Mr. Kingzett has extended his calculations to the pine and eucalyptus forests, which are so abundantly distributed in nature. Taking New South Wales and South Australia alone, he calculates that the eucalyptus forests of this district contain at any given moment sufficient oil in the leaves (ready to be evaporated into the atmosphere under the agency of warm winds) to form by contact with the atmosphere no less than 92,785,023 tons of pure peroxide of hydrogen, and 507,587,945 tons of camphoraceous principles. Now, if it be remembered that in nature all matters of animal and vegetable origin are oxidised by the atmosphere, which is thus kept free from the pernicious products of putrefaction, and that peroxide of hydrogen is a much more powerful oxidant than ordinary oxygen, and if it be also borne in mind that the camphoraceous products above referred to are also powerful antiseptic agents, then the healthful influences of the eucalyptus can neither be wondered at nor be longer open to any doubt. What is true of the eucalyptus is true also of the pine, and on an immensely larger scale, for pine forests are distributed freely over both hemispheres, and the oil of turpentine, which is a natural product of these trees, undergoes the same chemical changes in the atmosphere as oil of eucalyptus. By imitating this natural process of oil oxidation, Mr. Kingzett has, as is well known, succeeded in obtaining and rendering available in commerce the antiseptic and oxidising principles to which pine and eucalyptus forests owe their hygienic influences.

MENDELJEFF'S PERIODIC LAW AND THE MAGNETIC PROPERTIES OF THE ELEMENTS

By THOMAS CARNELLEY, D.Sc.

In 1845 Faraday showed that all matter was divisible into two classes—(1) *Para-magnetic substances*, or those which are attracted by a magnet and set axially when placed between its poles; (2) *Diamagnetic substances*, or those which are repelled by a magnet and set equatorially, or at right angles to the first position when placed in the magnetic field. He also determined qualitatively the magnetic properties of a large number of elements in the free state, with the following results ("Experimental Researches," vol. iii.):—

Para-magnetic Elements.—N, O, Fe, Ni, Co, U (Verdet, *vide* Lloyd's "Treatise on Magnetism"), Mn, Pt, Os, Pd, Ir, Rh, Cr, Ti, Ce, C (Ganot's "Physics," p. 807), K (Lamy).

Diamagnetic Elements.—H, Na,* Cu, Ag, Au, Hg, Zn, Cd, Pb, Sn, P, As, Sb, Bi, S, Se (Becquerel), Cl, Br, I. Also Tl (Crookes) and Si (Lamy, *Ann. Chim. Phys.*, li., 305).†

On comparing together the elements contained in these two classes, we seek in vain for any evident connection between their magnetic and chemical properties. For in both classes we have metals and non-metals, and in this arrangement many elements are separated which otherwise are nearly related, as in the case of K and Na, O and S, Au and Pt, N and P, As, Sb, &c. It has been stated (Watts's "Dictionary of Chemistry," iii., 773; Lothar Meyer's "Modernen Theorien der Chemie," p. 233) that elements with small atomic volumes as Fe, Ni, Co are mostly para-magnetic, whilst those with large atomic volumes are mostly diamagnetic. But to this rule there are many exceptions: thus K, with large atomic volume, is para-magnetic; and H, Cu, Ag, Au, Zn, Hg, and Cd, with small atomic volumes, are diamagnetic.

In his well-known memoir on the Periodic Law (*Ann. der Chem. u. Pharm.*, Sup. viii., 133) Mendeljeff gives a classification of the elements similar to that represented in the table below, and he points out that those elements of a given group which belong to even or to odd series resemble one another much more nearly than the odd members resemble the even members of the same group. I have lately been working on the subject of the influence of atomic weight on the properties of elements and compounds, and it occurred to me to compare the above magnetic list with this classification of Mendeljeff. When this is done, a most remarkable confirmation is obtained of the above theory of odd and even members of a group of elements, such that the following rule *invariably* holds good without a single exception in the case of the thirty-eight elements to which it can be applied:—*Those elements belonging to the* even *series of Mendeljeff's classification*

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* Abstract of a paper read before the Health Section of the Social Science Congress, Manchester.

* According to Faraday Na is strongly diamagnetic, whereas Lamy states it to be slightly magnetic.

† U and W *in combination* are, according to Faraday, very slightly diamagnetic; the magnetic properties of W in the free state have however, not been determined.

Series.	Group I.	Group II.	Group III.	Group IV.	Group V.	Group. VI.	Group VII.	Group VIII.
1	−H=1							
2	? Li=7	? Be=9·2	? B=11	+C=12	+N=14	+O=16	? F=19	
3	−Na=23	? Mg=24	? Al=27·4	−Si=28	−P=31	−S=32	−Cl=35·5	
4	+K=39·1	? Ca=40	—	+Ti=48	? V=51·3	+Cr=52·3	+Mn=55	+Fe=56; +Co=59; +Ni=59
5	−Cu=63·5	−Zn=65·2	? Ga=69	—	−As=75	−Se=79	−Br=80	
6	? Rb=85·5	? Sr=87·5	? Yt=89	? Zr=90	? Nb=94	? Mo=96	—	? Ru=104; +Rh=104; +Pd=106
7	−Ag=108	−Cd=112	? In=113	−Sn=118	−Sb=122	? Te=128	−I=127	
8	? Cs=133	? Ba=137	? Di=138	+Ce=140	—	—	—	,, ,,
9	—	? Ng=145*	—	—	—	—	—	
10	—	—	? Er=178	? La=180	? Ta=182	? W=184	—	+Ir=192·7;† +Os=195; +Pt=197·5
11	−Au=197·5	−Hg=200	−Tl=204	−Pb=207	−Bi=210	—	—	
12	—	—	—	? Th=231	—	+U=240	—	,, ,,

* The new metal, Norwegium, recently discovered by Dahll, appears to belong to this position.

† Seubert.

are always para-magnetic, *whereas those elements belonging to* odd *series are always* diamagnetic.

This is readily seen from the table above, in which the elements are arranged together with their atomic weights as in Mendeljeff's original memoir. The sign (+) signifies that the element to which it is attached is para-magnetic, the sign (−) that it is diamagnetic, and (?) that its magnetic properties in the free state are unknown.

At present I am unable to offer any explanation of these facts.

The specific magnetic powers of very few elements have as yet been determined, but judging from the few cases in which there are available data, it appears that as regards the odd elements of a group they become more and more diamagnetic as the atomic weight increases, thus:—

Specific Magnetic Powers.

Becquerel.			
S = −1·14	P = − 1·64	H = −0·001	(Faraday)
Se = −1·65	Sb = − 4·10	Cu = −1·68	(Becquerel)
	Bi = −22·67	Ag = −2·32	,,
		Au = −3·47	,,

In the eighth group, also, the para-magnetism appears to diminish as the atomic weight increases, for Fe, Ni, and Co are strongly para-magnetic, whereas Rd, Pd, Pt, Os, and Ir are but feebly so. According to Faraday, also, Pd is more magnetic than Pt and Os.

In conclusion, it follows that an examination of the magnetic properties of newly discovered, and of little known, elements would render considerable service in the determination of their positions in the general classification.

The Owens College, Manchester.

ON THE NASCENT STATE OF BODIES.

By Dr. T. L. PHIPSON, F.C.S., &c.

The note published in the last number of the Chemical News, by Dr. Tommasi, of Florence, demands a few words of remark.

Many years ago I showed that all bodies probably were susceptible of taking what is called the *nascent state*, a state in which their *electric* properties and powers of entering into combination are exalted to an extraordinary degree.

It would be rash to conclude from the single fact of the non reduction of perchlorate of potash quoted by Tommasi that the nascent state of hydrogen does not exist. Why should he draw such an abrupt conclusion from the investigation of some reactions given by one salt? Would it not have been as logical to conclude that nitrate of silver will not precipitate chlorine because when added to the said perchlorate it produces no precipitate of chloride of silver? Why did he not extend his researches to permanganate, &c.? I quite agree with him that the molecular notions of M. Wurtz fail to explain the phenomena in question.

In 1858 I brought forward a series of experiments in my paper on "La Force Catalytique, ou Etudes sur les Phenomènes de Contact," to which the Dutch Society of Sciences of Harlem awarded its gold medal, experiments which show that when oxygen and hydrogen combine in presence of platinum, iridium, phosphorus, humus, and other bodies, or when hydrogen precipitates gold from its perchloride in presence of a *third body*, an electric phenomena occurs in every case, and that we have here an exact reproduction of what takes place in the ordinary voltaic battery; that these substances are then in an exalted state identical with that known as the "nascent" state, that is, producing the same reactions.

A discussion arose on this subject some twelve or fourteen years ago at the Academy of Sciences at Paris, and the views put forward on that occasion by the elder Becquerel, by H. Deville, and others, showed that my interpretation of these so-called "catalytic" phenomena had been entirely adopted.

The nascent state of bodies is, therefore, no myth, as Prof. Tommasi would endeavour to make out for hydrogen. It is that peculiar exalted state which bodies assume as they enter into combination and as they leave a combination, a state in which their *physical* and *chemical* properties (especially their *electric* properties) are very different from what they are in the same bodies in a free state. Dr. Tommasi's experiments are very interesting as pointing once more to the peculiar nature of the salts formed by the oxacids of chlorine, but they throw no light on the *nascent* state of bodies.

ON A

POSSIBLE CAUSE OF VARIATION IN THE PROPORTION OF OXYGEN IN THE AIR.

By E. W. MORLEY, M.D., Ph.D.,
Professor of Chemistry in Western Reserve College, Hudson, Ohio.

Professor Loomis had proposed the theory that certain great and sudden depressions of temperature at the surface of the earth are caused, not by the transfer of cold air from higher to lower latitudes, but by the vertical descent of air from cold elevated parts of the atmosphere. The evidence supporting this theory was published in the *Am. Journ. Sci.* in January and July, 1875. It occurred to the writer some time since that if this theory were true, as the evidence makes very probable, the air at the surface of the earth during such a great and sudden depression of temperature might well contain a smaller proportion of oxygen than the average. Dalton reasoning from the fact that oxygen has a greater specific gravity than nitrogen, argued that the proportion of oxygen to nitrogen in the atmosphere should decrease with increasing altitude above the earth's surface; whether he clearly enough recognised that such a regular decrease would be realised only in an atmosphere in a state of equilibrium undisturbed by convection currents the writer does not know, not having seen Dalton's memoir. Such a decrease of atmospheric oxygen with increasing altitude has not yet been detected by analysis, although the amount of decrease, on the theory that oxygen and nitrogen are distributed in the atmosphere according to the law which would prevail in case of equilibrium, is so rapid that it would be detected with ease, even in altitudes attained in every holiday ascent of a balloon. This decrease may be calculated from the formula $R = R_0 0{\cdot}9832960^{H}$, where H denotes the height above the earth's surface expressed in kilometres, R_0 denotes the ratio of the tension of oxygen to that of nitrogen at the surface of the earth, and R denotes the same ratio for the height H. The constant is computed from the determinations by Regnault of the weights of a litre of oxygen and of nitrogen, and of the specific gravity of mercury. The following table gives in the second column the ratio of the tension of oxygen to that of nitrogen at the height in kilometres given in the first column, and the percentage of oxygen at the same height in the third column. The percentage of oxygen at the earth's surface assumed in the table is that used in the tables for gas analysis in Bunsen's Gasometrische Methoden.

It will be seen that the composition here calculated for a height of a single kilometre is so different from that at the surface that analysis of no very refined accuracy would detect the variation with ease. But no such variation has been detected even in samples of air collected at the greatest elevations attainable.

Height, kilometres.	Ratio of O to N. Per cent.	Per cent of O.
0	26·52	20·96
1	26·08	20·68
2	25·64	20·41
3	25·21	20·14
4	24·79	19·87
5	24·38	19·60
6	23·97	19·34
7	23·57	19·07
8	23·18	18·82
9	22·79	18·56
10	22·41	18·31
20	18·93	15·92
30	16·00	13·79
40	13·52	11·91
50	11·42	10·25
60	9·65	8·80
70	8·16	7·54
80	6·89	6·45
90	5·82	5·50
100	4·92	4·69

But although this is the case, it is certain that in the atmosphere of the same place at different times the oxygen varies by more than one-fortieth of its average amount. Variations so large as this are rare, but variations of the one-hundredth or two-hundredth part are common. It therefore seemed to the writer proper to examine whether facts bear out the conjecture that certain great and sudden local depressions of temperature are caused by the descent of cold air from the upper part of the atmosphere, and that such air may by its poverty in oxygen throw some light on a question in meteorology and a question concerning the physics of a mixture of different gases.

In the number of *Wiedemann's Annalen* for April of the current year, Jolly has published the results of numerous and very accurate analyses of atmospheric air. He asserts a connection between the variations in composition detected and the direction of the winds when the sample was collected. He considers himself justified in concluding that the atmosphere of tropical regions is poorer in oxygen than that of polar regions, and supposes that at the equator more oxygen is consumed in processes of oxidation than is set free by those of reduction, while the opposite is true near the poles. Since no difference in the composition of the atmosphere at the equator and at the poles has been detected, while on this theory the difference must be one large enough to account for the extreme variations found in temperate regions, and to account for them after such abnormal air had been exposed to admixture with air of a different composition during a passage of thousands of miles, the writer fears that the theory of Jolly will need further proof. Other reasons for a similar doubt will suggest themselves.

On the writer's theory, a sample of air collected at the centre of an area covered by a descending current of cold air would at some given instant be a sample fresh from the upper part of the atmosphere, but little exposed to admixture on the way. If before its descent it had remained at a great height for a long time, it might well have lost some of the oxygen which it contained when it was at some previous time at the level of the sea, and the difference might be enough to be detected. An observer at one side of this central point would have samples more or less mingled with surface air; but even then, a deficiency of oxygen might be detected by accurate analysis.

The writer hopes to make arrangements for the regular collection of samples at points which Professor Loomis has indicated as regions of frequent descent of cold air from great heights. But while laying plans for the work, he has thought best to ascertain whether some light on the change sin the constitution of the atmosphere might be obtained by analysing samples of air collected at home. Having an apparatus for gas analysis lately constructed for the study of the gas issuing from the numerous gas wells of his vicinity, he used this for such determinations. In general, the apparatus is constructed on the plan of McLeod's modification of Frankland and Ward's apparatus. But some important modifications have been introduced, and excellent workmanship was bestowed on details. Some such points but slightly concern analysis by explosion. The connection between the eudiometer and absorption-tubes is novel, and has worked well. This will be described in some proper connection. Here will be described everything necessary for a judgment of the accuracy of the analysis to be cited.

The eudiometer and pressure tubes were made from the writer's drawings by Geissler, whose recent death is a loss to science, and a personal loss to so many who have been aided by him. The stop-stocks at the the top of these tubes will retain a Torricellian vacuum for weeks. The internal diameters of the tubes are 20·9 and 10·7 millimetres. At the lower end of the eudiometer tube is a glass stop-cock, the use of which is simply to permit the ready cleaning of the tube. Its glass plug is withdrawn, and in place of it is put one of vulcanite so bored that acids or water can be aspirated through the eudiometer without dismounting it and without drawing off the mercury from the pressure tube. The stop-cock at the top of the eudiometer tube is also provided with a similar plug for the same purpose. The pressure and eudiometer tubes are surrounded by a stream of water entering at the top of the pressure tube and running away from near the bottom of the two. The level of water is kept constant by a device similar to that of Thomas, described in a late number of the *Journal of the Chemical Society*, but perhaps superior to his in some respects. The flow of mercury to and from the movable reservoir is controlled by an iron stop-cock which is attached to the iron tripod support of the whole apparatus. The plug of this stop-cock is vertical, and is prolonged by a shaft which puts it within easy reach of the observer. By means of a long handle on this shaft, the stop-cock can be moved with the greatest delicacy. From this stop-cock, an iron tube, cast in the same piece, extends under the ends of the glass tubes of the apparatus, and two small iron tubes rise from this horizontal tube; these last meet the glass tubes and are connected with them by short tubes of patent black rubber containing no free sulphur. The connectors are tied so as to endure the pressure of mercury having a head of several feet, and are surrounded with mercury so as to be absolutely air-tight. The plug of the iron stop-cock is also so surrounded with mercury that the entrance of air is absolutely impossible, and the same precaution was taken at the junction of the two small iron tubes with the horizontal tube. The cast iron of this tube and stop-cock is well japanned, and no leakage through its pores has occurred.

The measurement of the volume of gas in such an apparatus demands an accurate adjustment of the level of the mercury in the eudiometer tube to one of the marks of the graduations. Such an adjustment can be accurately made by admitting mercury very slowly from the reservoir, and closing the stop-cock at the required moment. But if now the temperature of the gas be not quite constant, the adjustment can be renewed for a second reading only by letting in or out a column of mercury of several millimetres, again permitting it very slowly to approach the proper level, and stopping at the instant of contact. It is quite impossible to open the stop-cock, admit the twentieth or fortieth of a millimetre of mercury, note the right instant, and then again close the stop-cock. But for accurate work, the means of altering the level of the mercury by such small quantities, and of doing it by a continuous movement, seemed important. In the end, therefore, of the horizontal iron tube, there works a plunger, packed with great care, which can be moved in or out by a screw. By means of this micrometric movement, the level of the mercury which has been adjusted by the stop-cock can be altered with the greatest delicacy, and re-adjusted till perfect steadiness is attained. Danger of leakage through the washers around the plunger was prevented by providing a seat into which, when the plunger is screwed quite home, it fits so as to cut off connection between the pressure tube and the rest of the apparatus. The mercury in the pressure tube is, by the use of this valve, always kept at such a height that any possible leakage is that of mercury outward, and not of air inward.

The eudiometer and pressure tubes are cemented into the brass cap of the glass cylinder containing the water intended to keep all parts of the apparatus at the temperature. The level of the two graduations with respect to each other is therefore constant.

(To be continued.)

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. VIII.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

1. (46.) *Analysis of Volcanic Ash from a Recent Eruption of Cotopaxi.* By J. R. Santos, of Guayaquil, Eçuador.

The material for this analysis was sent to Senor Santos by a member of his family living at Bahia de Caraguez, on the coast of Eçuador, at which place it fell in large quantity on August 23, 1878. The distance from Cotopaxi is about 120 miles. The eruption of the volcano is reported as having been distinctly seen from Guayaquil.

The ash was very fine, of a brownish grey colour, and appeared under the microscope to consist of nearly uniform, transparent, glassy granules, with a small admixture of reddish brown ferric oxide. It contained no particles sensibly attracted by the magnet. Heated in the blowpipe flame it fused with intumescence to a brownish yellow bead. Hydrochloric acid dissolved the oxide of iron without materially affecting the rest of the ash. Fused with borax, the reaction for iron was obtained. Lead was detectable only after decomposition by fusion with an alkali, and appears therefore to have existed as silicate. Due precaution was used to prove that it was not derived from any of the reagents or vessels employed.

Specific gravity of the ash, properly deprived of air, =2·743. The analysis gave—

SiO_2	56·661
Al_2O_3	19·398
Fe_2O_3	7·523
PbO	0·575
CaO	6·229
MgO	trace
Na_2O	6·123
K_2O	2·425
H_2O	0·862
	99·796

Neglecting the ferric oxide, most of which at any rate was undoubtedly mixed with the silicate, and throwing out also the water as non-essential, the above figures approximate to those for certain lavas and trachytes, and lead pretty nearly to a formula of felspathic type,—

$$\left\{\begin{matrix}K_2\\Na_2\\Ca\\Pb\end{matrix}\right\}Al_2Si_5O_{14},$$

but it is by no means certain that there may not have been more than one silicate present.

For the sake of comparison, the following analyses of volcanic ashes, already on record, may be quoted:—

	Vesuvius (1822). Dufrenoy.	Etna (Crater).	Etna (Catania).	Hecla (1845). Gentk.	Hecla (1845). Ashes on Orkney. Connell.	Gunung Gunter (Java). Schweizer.
		V. Waltershausen.				
SiO_2	53·67	48·737	46·309	56·89	59·20	51·64
Al_2O_3 ..	17·94	17·886	16·846	14·18	15·20	21·89
Fe_2O_3 ..	—	12·756	9·850	—	9·60	—
FeO	5·75	—	4·430	13·35	—	10·79
MnO	—	—	—	0·54	—	—
CaO	1·92	5·495	10·276	6·23	4·82	9·34
MgO	7·15	2·534	5·439	4·05	0·60	3·42
Na_2O ..	9·55	4·502	3·340	2·35	6·74	2·92
K_2O	4·02	2·045	1·411	2·64		0·55
Cl and SO_3	—	—	2·207	—	—	—
H_2O	—	6·630	—	—	—	0·60
	100·00	100·585	100·108	100·23	96·16	101·15

The occurrence, in the ashes from this Cotopaxi eruption, of lead to the extent of more than 1-200th of the whole mass, which must in the aggregate have been enormously large, is interesting, as is also the different state of combination in which the metal occurs from the already known, though comparatively rare, chloride (Cotunnite) of Vesuvius, eruptions of 1822 and 1855.

2. (47.) *Chemical Composition of "Livingstoneite" from Huitzuco, Guerrero, Mexico.* By F. P. Venable, of Charlottesville, Virginia.

This mineral was described by Mariano Bárcena, of the City of Mexico, in 1874*, and named by him in honour of the African traveller, Dr. Livingstone. According to the original account it resembles in general aspect native antimony sulphide, with which it is apparently isomorphous. It is found in columnar groups and imperfectly detached prisms of bright lead-grey colour, with red streak, instead of the black streak of stibnite. Hardness =2. Sp. gr. at 16° C. = 4·81. Fuses at the first touch of the blowpipe flame, giving off copious white fumes. Not sensibly attacked by cold nitric acid, but dissolved by the heated acid, leaving a white residue. Affords the reactions of sulphur, antimony, and mercury. Analysis gave Senor Bárcena—

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* "Naturaleza," iii., 35 and 172. *Amer. Journ. Sci.*, August, 1874, 145; January, 1875, 64.

Sulphur	29·08
Antimony	53·12
Mercury	14·00
Iron	3·50
	99·70

Whence the atomic ratio was deduced, S : Sb : Hg : Fe = 18·17 : 8·7 : 1·4 : 1·2, or, nearly, 15 : 7 : 1 : 1, with the formula $4Sb_2S_3 + HgS + FeS_2$, involving an excess of 1 atom of antimony. This ratio, according to my calculation, should rather be 13 : 6·2 : 1 : 0·9, or 13 : 6 : 1 : 1. The mineral occurs at Huitzuco, in the State of Guerrero, in a matrix of carbonate and sulphate of calcium, along with native sulphur, cinnabar, valentinite, and stibnite.

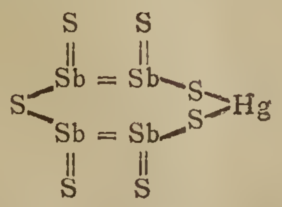
Recently Senor Bárcena has sent me some specimens of this mineral, stating that he has reason to think them purer than those formerly analysed by him, and requesting me to revise the question of chemical composition, about which he entertains some doubt. The material received agrees in all respects with the above description. The choicest portions have been carefully analysed by Mr. Venable. It was ascertained that even in these selected fragments calcium sulphate and free sulphur existed, the former soluble in water or weak hydrochloric acid, the latter in carbon disulphide. The ore was dissolved by prolonged digestion with nitro-hydrochloric acid. In one experiment, the antimony thrown down as sulphide was deprived of surplus sulphur by heating in an atmosphere of carbon dioxide: in another, sulphur was determined by oxidation with nitric acid and precipitation as barium sulphate. From one specimen the total sulphur was gotten by oxidation in the liquid way; from another by fusion with sodium nitrate and carbonate. Tne quantity of mercury present was checked by distillation of a separate portion with lime. The results were—

	I.	II.
S (combined)	20·43	19·64
S (free)	3·97	3·57
Sb	46·49	44·26
Hg	19·56	18·47
Fe	0·16	0·10
$CaSO_4.2H_2O$	7·55	12·59
Insoluble residue	0·52	
Moisture	0·89	
	99·57	

It is manifest that iron is not an essential ingredient. Deducting this and the calcium sulphate, free sulphur, &c., of the matrix, and re-calculating percentage, we have the following figures:—

	I.	II.	Mean.
S	23·62	23·84	23·73
Sb	53·76	53·74	53·75
Hg	22·62	22·42	22·52
	100·00	100·00	100·00

Hence the atomic ratio S : Sb : Hg = 7 : 4·2 : 1, which gives the formula $HgS.2Sb_2S_3$, or—



This is remarkable as representing the most strongly acid sulph-antimonite as yet known, since zinkenite contains Sb_2S_3 but once for PbS. The corresponding oxygen salt would be intermediate between the mono- and tri-antimonites of Terreil.

3. (48.) *Analysis of Magnetite exhibiting unusual Crystalline Distortion, from Henry Co., Virginia.* By Edwd. C. Smith, of Richmond, Va.

The mineral occurs in loose crystals, for the most part from 15 to 30 m.m. through, on the land of Mr. J. P. Barksdale, in Henry County. There is a thin crust of ferric hydrate on the outside, but most of this is easily brushed off. The greater part of each crystal has the ordinary black colour and general appearance of magnetic iron. Hardness = a little under 6. Sp. gr. = 4·98. Strongly magnetic, but with no very distinct polarity. Many of the crystals are curiously distorted by minute step-like projections or depressions of parts of the surface, like those of some diamonds, fluor-spar cubes, &c., so that the general aspect is that of a rhombic octahedron, but with irregularly varying inclination of the general surfaces to each other, such angles as 107°—15', 104°—10', 100°—55', 102°, 104°—18', 109°—30', 106°—05', 102°—48', and 115, being obtainable with the common goniometer of application. So minute are the successive steps that the appearance is strongly suggestive of true crystalline form other than monometric, and pseudomorphism was at first suspected. A certain amount of irregular pitting of the surface is also observable under the crust, the result of chemical change to ferric hydrate.

Analysis by Mr. Smith of the clean interior portions of the crystals gave—

FeO	30·56
Fe_2O_3	67·94
Insoluble residue (quartz)	1·56
	100·06

corresponding accurately to simple magnetite. There was no titanium present.

4. (49.) *Analysis of Crude Rock-salt from Saltville, Washington Co., Virginia.* By B. E. Sloan, of Charleston, South Carolina.

Large supplies of salt are now, and for a long time have been, obtained in this neighbourhood, in the extreme south-western portion of the State, by boiling down brine, originally found issuing naturally from the ground, but for which exit on a larger scale has been artificially produced by digging and boring. In the course of these excavations the underlying solid salt has been occasionally exposed, though never worked on an industrial scale. A year or two ago I received from the superintendent of the works some specimens of dark brownish red crystalline rock-salt, thus taken out during the deepening of one of the salt wells, and a portion of this material has, as an example for practice, been analysed by Mr. Sloan. He found—

NaCl	89·21
KCl	trace
$CaSO_4.2H_2O$	4·86
Fe_2O_3	0·84
SiO_2	4·53
	99·44

No strontium, barium, or lithium could be detected. Some thin translucent plates of ferric oxide were visible under the microscope in the residue insoluble in water, but nothing like the beautifully regular crystalline spangles obtainable from the Carnallite of Stassfurt.

5. (50.) *Analysis of "Tungsten-Manganese Bronze."* By F. P. Venable, of Charlottesville, Va.

Amongst a number of preparations of tungsten lately received from E. W. L. Biermann, of Hannover, were sundry alloys purporting to contain this metal in union with others. As two or three cases have of late years been published of alloys supposed to contain the more refractory metals, as tungsten, chromium, titanium, &c., and for which special merit was on this account claimed, while little or none of the metals in question could be found on analysis, it seemed worth while to examine at least one or two of these German specimens. A fragment cut from a small block of so-called tungsten-manganese bronze, of light gold-yellow colour, pretty close grain, and with a fine polish upon one side of the specimen (sp. gr. =8·64), was carefully tested qualitatively, and the proportions of the constituents found were thus determined. No manganese whatever was present, and but an insignificant amount of tungsten. The alloy consisted of—

Cu	86·51
Sn	9·04
Zn	3·47
Fe	0·26
W	0·23
	99·51

It is therefore but an ordinary gun-metal, with part of the tin replaced by zinc. Of course manganese may have been added in its production, as well as a larger proportion of tungsten; but if so, they have failed to be taken up, or have been burnt out before the alloy was cast; and manganese so removed may have served in a measure to improve the compactness and homogeneity of the mass by carrying off with it oxygen from the remaining metals, as in the use of phosphorus in making "phosphor-bronze. But the name under which the alloy is sold is calculated to mislead purchasers.

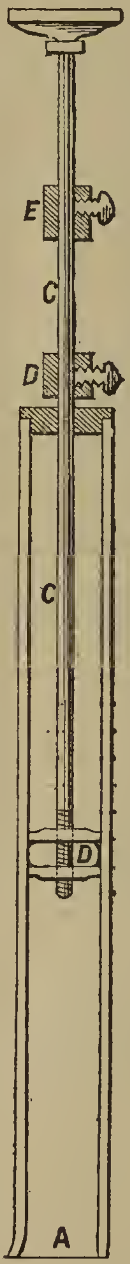
(To be continned.)

Presence of Alcohol in Animal Tissues during Life and after Death in Cases of Putrefaction from a Physiological and Toxicological Point of View.—J. Béchamp.—MM. Schrader and Dusch have shown that well-cooked meat may be preserved for several weeks without alteration in presence of filtered air; and that meat heated in the water-bath, so as merely to coagulate the surface, became putrid under the same conditions. In order to find out the cause of this decomposition, the author performed the following experiment:—A piece of horse flesh, weighing 3 kilos., was plunged for ten minutes in boiling water, so as to coagulate the surface, and was then placed in a crystallising pan covered over with a very compact linen cloth. After the lapse of thirty-eight days the vessel was opened. A small quantity of liquid had collected, which swarmed with Vibriones. The odour of the meat was offensive, but distinct from that of ordinary putrefaction. On cutting the meat open to examine the central part the muscular striation had disappeared. Under the microscope were found a very few free Microzymas in the free state, and a larger number associated; a great quantity of various Bacteria (*B. termo*, *articulatum*, and *capitum*), and even a few *Leptothrix*, but not a single *Vibrio*, a fact proving that the air had not penetrated into the interior. From the mass the author isolated about 0·8 grm. of alcohol, the identity of which was demonstrated by the usual reactions, along with 10 grms. of sodium acetate and butyrate, and salts of acids higher than the butyric. Hence putrefaction completely approaches in its nature to fermentation properly so-called. But during life the transformations which are effected within animal tissues are due also to microzymes, and approximate consequently to fermentation. Hence alcohol should be present in the organs. Experiments on the liver and the brains of sheep and the brains of oxen clearly showed its presence. These facts have a deep interest, both physiologically and toxicologically. The presence of alcohol in the tissues can no longer be considered a proof of its ingestion previous to death.—*Comptes Rendus*, lxxxix., No. 12.

BURETTE FOR COLLECTING, MEASURING, AND DELIVERING GASES OVER MERCURY.*

By PHILIP BRAHAM, F.C.S.

The burette consists of a divided glass tube open at both ends, the lower end, A, having a lip, the upper end being covered with a loosely fitting boxwood cap. A piston, B, formed of a disk of india-rubber between two plates of steel connected with a steel rod, C, is fitted into the tube.



To fill the burette, the piston is depressed below the lower end until a portion of the mercury escapes above it. On drawing it up any portion of the tube can be filled. When the gas has been delivered the measurement may easily be made by lowering the piston till the mercury inside is level with that on the outside, and the contents read off. By further depression of the piston, and placing the lip under a eudiometer, any required amount of gas may be delivered for analysis, the clamp E being used to stop the piston when the required amount is discharged. The clamp D is used to prevent the piston descending when the instrument is full of mercury.

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* Read before the British Association for the Advancement of Science Section B.), Sheffield, 1879.

NOTICES OF BOOKS.

Chemical Denudation in Relation to Geological Time. By T. Mellard Reade, F.G.S. London: David Bogue.

In view of the recent attempts made by certain physicists to fix a maximum limit for the past existence of the earth—attempts characterised not more by their extreme assumptions than by the conflicting character of their results—geologists and biologists are naturally led to revise the evidences in favour of a far higher terrestrial antiquity. Mr. Reade, in the work before us, takes what we believe to be novel ground. By "chemical denudation" he understands the quantity of dissolved matter carried down from the land to the sea by rivers, and hence primarily by the rainfall. The proportions of carbonates and sulphates of lime and magnesia, of chloride of sodium, besides certain minor constituents, are taken from the analyses of Prof. Frankland in the "Reports of the Pollution of Rivers' Commission," and from the researches of Prof. Bischoff on the principal European rivers. The quantity of water run off by the rivers—a much smaller amount, of course, than the annual rainfall—is next taken into consideration. The remaining elements in the calculation are the total contents of the ocean, 2,494,500 billions of tons, according to Herschell, and the analysis of sea-water as given by Prof. Frankland, which shows 48·9 tons carbonate of lime and magnesia, and 1017 tons of the sulphates of the same bases; and, lastly, 3259 tons of common salt per 100,000 tons of water. Hence it would take 480,000 years to introduce into the ocean its present proportion of the carbonates of lime and magnesia, 25 million years to supply the sulphates, but 200 million years to furnish the salt. It may be incidentally mentioned that the sodium chloride existing in solution in the ocean is sufficient, if solidified, to cover the whole of the dry land with a bed of salt 914·9 feet in thickness. These 200 million years the author considers as an inferior limit.

In the second section of the work, a paper on the "Geological Significance of the Challenger Discoveries," the author points to the coldness of the bottom of the ocean at great depths as a proof of the extreme slowness of the secular cooling of the earth. He considers that the accumulation of one foot of chalky clay over the bottom of the ocean must require 20,000 years, and a foot of red clay probably ten times as long. He concludes also that even the deep seas have at one time been continents. Thus "the molluscous fauna of the eastern coast of North America is very similar to that of Europe," which could not have happened without littoral contiguity.

The remaining portion of the work is a paper read before the Royal Society on "Limestone as an Index of Geological Time." The author's results may be thus summarised:—Taking the average rainfall run off the igneous ground during all geological time at 28 inches per annum, and the amount of carbonate and sulphate of lime it takes up from the igneous rocks at 4·00 per 100,000, the annual yield of the land in those forms of lime would be 71·68 tons yearly per square mile. Calling it 70 tons, one-tenth of the area of the land, or 5,100,000 square miles, would yield 357,000,000 tons yearly of these minerals. The total area of the globe is 196,900,278 square miles, so that the land would yield to the whole globe 1·813 tons per square mile yearly. At $13\frac{1}{2}$ cubic feet to the ton it would take 1,139,032 years for the accumulation of a deposit one foot in thickness. Therefore 528 feet thick, the supposed minimum thickness of limestone in the sedimentary crust of the earth, would be eliminated from the original material of the earth in 601,408,896 years.

Prof. Ramsay, from "considerations of a mixed physical and palæontological character," assigns to the groups from the Laurentian down to the Post Pliocene a total time of 600 million years.

Space will not permit us to enter into the arguments which may be presented on both sides of this important question. But we must admit that the author has very fairly and ably met the majority of the objections which may be urged against his views.

CORRESPONDENCE.

RUSTLESS IRON.—BARFF'S PROCESS.

To the Editor of the Chemical News.

Sir,—The great interest which has been taken in Prof. Barff's process for the prevention of corrosion on iron surfaces by all persons connected with the iron trade leads us to believe that it would be interesting for your readers to know that we are now supplying all kinds of "Anti-Corrodo" iron goods by license under Prof. Barff's patent, and which obtained two Medals at the Paris Exhibition. The process, shortly, consists of passing superheated steam over the iron goods to be treated whilst at a red-heat, and can be applied to all kinds of iron-work, rendering it absolutely rustless at a less cost than galvanising, so substituting an absolute protection for one which confessedly is but partial in its action and easily removed. Amongst "Anti-Corrodo Goods," wrought-iron tubes stand out prominently, as they and a host of similar goods are peculiarly well adapted for the application of Prof. Barff's process, and we have an iron chamber 12 feet long specially built for treating this class of goods, whilst a chamber 7 ft. × 3 ft. × 13 ft., which we built to coat a large quantity of large iron railings for the Duke of Norfolk, enables us to treat all kinds of iron-work of any ordinary dimensions for manufacturers and others interested in the process.

A report of Sir Joseph Whitworth goes to prove that the iron is slightly improved in strength by the process. Many of the articles first treated are in our possession, and although they have been exposed to the severest of tests by various firms and gentlemen in whose possession they have been, in some cases over two years, they present no appearance of corrosion, and are, as claimed for them, rustless and incorrodable.—We are, &c.,

The Rustless and General Iron Co.,
James E. Spencer.

97, Cannon Street, E.C.

PYRITES-SMALLS IN THE MANUFACTURE OF SULPHURIC ACID.

To the Editor of the Chemical News.

Sir,—A person under the name of "Sulphur" enquires as to the cheapest way of using up pyrites-smalls in manufacturing sulphuric acid. I beg to refer him to the excellent manual of Professor Lunge, of the Zürich Polytechnikum, recently published by Van Voorst, "On the Alkali Manufacture." He will there find an account of a simple kind of furnace or burner where the smalls are arranged on shelves, placed alternately under one another so that the ore may be gradually worked downwards, and falls at length to the lower part of the oven very satisfactorily burnt. This form of burner is used in a vitriol works on the side of the Lake of Zürich, and I know it is a success, for *smalls alone* are used there, to the best of my knowledge. I have myself seen this form of burner in operation, and to me it seemed to answer perfectly. Speaking from memory, I believe I was told the ore could thus be burnt down to 5 per cent of residual sulphur as a maximum.—I am, &c.,

Watson Smith, F.C.S., F.I.C.

Stretford, near Manchester.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 12, September 22, 1879.

Evolution in Medicine.—C. Sedillot.—Remarks on medical progress, in which the author quotes the aphorism of Hippocrates, "everything is natural and everything is divine."

Influence of Atmospheric Electricity on the Growth, Inflorescence, and Fructification of Plants.—M. C. Naudin.—The author, referring to the experiments of MM. Grandeau and Lecleic, at Nancy, in which plants of tobacco and maize were withdrawn from the influence of atmospheric electricity by being enclosed in wire cages or placed near large trees, and were found in consequence to be retarded and impoverished in their growth and fructification, describes similar experiments, which he has conducted at Antibes upon kidney beans, lettuce, tomatoes, and the herbaceous cotton-plant. The results were, however, exactly the reverse, the plants being benefitted, though to an unequal extent, by being withdrawn from atmospheric electricity. The weight of fruit obtained from the tomato was slightly more than double the weight obtained from a plant placed otherwise under conditions exactly similar. He concludes that the action of electricity, like that of heat, light, and moisture, varies upon different species of plants.

Theoretical Essay upon the Law of Dulong and Petit: Case of Perfect Gases.—H. Willotte.—A mathematical paper, not suitable for abstraction.

No. 13, September 29, 1879.

Researches on the Effects and the Mode of Action of Substances used in Antiseptic Dressings.—MM. Gosselin and A. Bergeron.—Experiments on the behaviour of blood mixed with known quantities of phenol, of alcohol at 86 per cent, and of camphoretted spirit.

Theoretic Essay on the Law of Dulong and Petit.—H. Willotte.—A continuation of the memoir inserted in No. 12. The author treats here of solids, liquids, vapours, and compound bodies.

Vibratory Forms of the Bubbles of Glyceric Liquid.—C. Decharme.—The author proposes three laws:—For the same number of nodals (the same system) the diameters of the bubbles are proportional to the lengths of the vibrating plate, or inversely proportional to the square roots of the numbers of vibrations. For the same diameter of bubbles the numbers of nodals are inversely proportional to the lengths of the vibrating plates, and directly proportional to the square roots of the number of vibrations. For the same length of vibrating rods the numbers of nodals are proportional to the diameters of the bubbles.

Action of Metallic Nitrates upon Monohydrated Nitric Acid.—A. Ditte.—Metallic nitrates may act upon monohydrated nitric acid in three very different manners. Ammonium nitrate combines with nitric acid to form an acid salt, which, at ordinary temperatures, dissolves a large quantity of melted ammonium nitrate, forming another acid salt. Potassium nitrate yields an acid salt in the same manner, as do also thallium and rubidium nitrates.

Thermic Researches on Succinic Acid and its Derivatives.—P. Chroustchoff.—Succinic acid dried in the water-bath and sifted gives, on solution in 500 c.c. at 11°, an absorption of heat:—$C_8H_4O_8H_2$ −6·4 cals.

A New Curare, Extracted from a single Plant (Strychnos triplinervia).—MM. Couty and de Lacerda.—The authors have obtained from the bark of this *Strychnos*—a species common in the province of Rio Janeiro—an extract, which, though weaker than that prepared by the Aborigines, gave, when introduced into the blood or under the skins of animals, the well-known symptoms of curare.

Moniteur Scientifique, Quesneville. September, 1879.

A great part of this issue is devoted to a review of the *Splendeurs de la Foi*, of M. l'Abbé Moigno. Save the usual reports of the meetings of the Academy of Sciences, the rest of the number is taken up with Mr. Perkin's history of alizarin, and Dr. O. H. Witt's paper on "A new Class of Aniline Colours," both from well-known English sources, and with a paper on the "Reynier" electric lamp, which cannot be reproduced without the accompanying illustrations.

October, 1879.

Aniline-Black.—R. Kayser.—The author has prepared aniline-black by different methods, and has found that when pure aniline was used the base formed possessed the composition $C_{12}H_{10}O_2$, Reinek's nigranilin. This base is insoluble in water, alcohol, ether, and chloroform; soluble in creosote and aniline with a blue colouration, rapidly turning brown under the influence of heat. In sulphuric acid it dissolves with a violet colour. The sulphate and hydrochlorate are decomposable by water. The formation of nigranilin takes place in acid solutions only; the presence of a metallic salt is not necessary, especially if there is an excess of a mineral acid. The author's experiments show that toluydin does not take part in the formation of aniline-black, and that in practice a pure aniline should be used. With reference to the view of M. Nietzki that aniline-black contains two isomeric bases, the one easily soluble in chloroform and aniline with a blue-violet colour, and the other, less readily, with a brown, the author has not observed a base soluble in chloroform.—*Verein. Beförder. Gewerbfleisses.*

Aniline-Black.—R. Nietzki.—The author refutes the assertion of M. Dechend that aniline-black is an oxygenated base, $C_{24}H_{17}N_3O_2$. Aniline-black, which possibly approaches the indulins, is of a violet colour when free, and green when existing as an acid salt, but these shades are sufficiently intense to pass for black.—*Verein. Beförderung. Gewerbfleisses.*

The remainder of the papers in this issue have either been already noticed, or are derived from English sources.

Justus Liebig's Annalen der Chemie, Band 198, Heft 1 and 2.

Communication from the Chemical Laboratory of Greifswald.—This consists of a memoir by Dr. O. Zander on the amido-disulpho-benzolic acids, which the author obtains by heating the three amido-sulpho-benzolic acids with fuming sulphuric acid.

Influence of Volume and Temperature in the Preparation of Ozone, and Description of a New Ozonisator.—A. R. Leeds.—At the temperature of +6° no ozone appears to be formed. From this point the yield increases till the temperature reaches +24°, after which it again decreases in a corresponding manner. In preparing ozone by means of the slow combustion of phosphorus, the author uses, instead of water, a solution of potassium dichromate mixed with sulphuric acid, and aspires or forces a current of air over the phosphorus, as first proposed by A. Riche. For the requisite tubes he finds a certain quality of "kerite," manufactured by Mr. A. G. Day, the best material.

Communications from the Laboratory of the University of Halle.—These consist of memoirs by W. Heintz on the oxidation-products of di- and tri-aceton amin, especially on amido-dimethyl-acetic acid, amido-dimethyl-propionic acid, and imido-dimethyl-acetic-dimethyl-propionic acid; on the chromates of tri-acetonamin, and on the compound of platinum chloride with the hydrochlorate of urea.

Preparation of Perbromic Acid.—Dr. G. Wolfram.—The author finds that perbromic acid is not formed by Kämmerer's process.

Researches from the Laboratory of Prof. T. Zincke.—This collection comprises memoirs by M. Rhalis on ortho-brom-benzoic acid; by T. Zincke, on compounds of the hydrobenzoin and stilben series; by A. Breuer and T. Zincke, in continuation of the last paper, and on the bodies formed by the action of dilute sulphuric acid on hydro- and isohydro-benzoin; and by T. Zincke, on the isomerism between hydro- and iso-hydro-benzoin. In this memoir the author discusses the question of physical isomerism, not to be explained by a different grouping or position of molecules. He suggests the assumption of different physical molecules, consisting of identical chemical molecules.

Contribution to the Knowledge of Glyoxylic Acid.—Dr. Carl Böttinger.—The transition of glyoxylic acid into oxalic acid and glycolic acid is connected with the decomposition of a salt of definite composition. With hydrocyanic and hydrosulphuric acids, glyoxylic acid behaves similarly to pyruvic acid. By ammonia it is converted into amido-glyoxylic acid, and by aniline into anil-glyoxylic acid. Glyoxylic acid behaves as an aldehyd and may be distinguished from pyruvic acid by its less tendency to condensations, due to the absence of a hydrocarbon residue.

Carbo-hydrates of the Tubers of the Jerusalem Artichoke (Helianthus tuberosus).—Dr. E. Dieck and B. Tollens.—In the tubers examined little or no inulin was found, but considerable quantities of levulin and of a dextrorotatory sugar. The composition of levulin is $C_6H_{10}O_5$, as is also ascribed to gum, starch, and dextrin. It is optically inert, has a great similarity to gum and dextrin, and in contact with yeast passes into the alcoholic fermentation. If boiled with sulphuric acid it yields levulinic acid. The sugar formed from levulin reduces Fehling's solution strongly, and has a specific rotatory power to the left (a) 4D at 20° C. = 52° referred to levulin, and 47° referred to sugar. In the fermented juice mannite and glycerin have been detected, and on one occasion succinic acid.

Isomeric Nitro-salicylic Acids.—H. Schiff and F. Masino.—Not suitable for useful abstraction.

On Di-iod-nitro-phenols.—R. Piria.—The author has obtained di-ido-nitro-phenol in two isomeric modifications, the one forming pale yellow rhombic prisms, and the other gold-coloured micaceous plates, like iodide of lead.

Chemiker Zeitung.
No. 37, 1879.

Alizarin Blue.—G. Auerbach.—Tissues dyed with this colour are much affected by light. An exposure to the sun for two or three hours is sufficient to convert the original bright blue shade to a dull grey. This want of permanence, joined to the high price of the colour, have greatly limited its consumption, and since the introduction of methylen blue, which dyes cotton without the intervention of a mordant, alizarin blue has disappeared from commerce. It is prepared by heating 1 part of mono-nitro-alizarin, as dry as possible, with 1½ part glycerin, and 5 parts sulphuric acid. After the reaction is over the mass is boiled in water, yielding a deep brownish red solution, from which, on cooling, the colour is deposited as a sulphate in brown crystals. This compound, however, can exist only in a strongly acid solution. On filtration and washing with water, the brown mass turns blue, and the colour is thus obtained in the free state. It may be re-crystallised from amylic alcohol, from glacial acetic acid, or from naphtha. The composition of alizarin blue is

$$C_{17}H_{11}NO_4+H_2O.$$

If heated to 180° with acetic anhydride it yields di-acetyl-alizarin blue, an unstable compound.

No. 38, 1879.

In connection with the general Congress of German Apothecaries, held at Hanover on September 4, was exhibited a collection of pharmaceutical antiquities, including a specimen of genuine oriental bezoar, a goblet of metallic antimony, formerly used for imparting a purgative effect to wine or beer, a venerable sample of "Album Græcum," &c., a selection of chemical apparatus inscribed with alchymistic symbols, a gaily-adorned jar for containing "Mithridate," &c.

Atti della R. Accademia dei Lincei.
Fascicolo 7, 1879.

Theorems on the Distribution of Constant Electric Currents.—Prof. G. Ferraris.—Briot, in his *Traité de la Chaleur*, having observed that in filiform conductors traversed by constant galvanic currents, as the law of Joule is a consequence of the law of Ohm, reciprocally the latter is a consequence of that of Joule, Ferraris generalises this theorem for conductors of any form soever.

Crystallographic Studies on Certain Bodies of the Aromatic Series.—Giuseppe la Valle.—Not capable of useful abstraction.

Glycerin and the Pancreatic Digestion.—Prof. A. Herzen.—The author, in opposition to Prof. F. Lussana, shows that the pancreatic liquid is pre-eminently the digestive secretion, acting upon the albuminoids as well as upon amylaceous and fatty bodies. He also refutes the objection that the albumin is dissolved by glycerin used for the extraction of the pancreatic secretion.

Nature of the Specific Agent which Produces Malarial Fever.—Prof. Edwin Klebs.—The cause of malaria is not equally developed in soils of like composition and equally moist, and it may hence be suspected to be a specific organism, requiring for its development not merely favourable outward circumstances, but also the presence of a germ. From the air of malarial districts aspirated through suitable apparatus the author has obtained organisms of about 0·95 micro-millimetres in maximum diameter, capable of producing malarial fever on inoculation. For these the author proposes the name *Bacillus malariæ*. They are developed in presence of free oxygen, and belong therefore to the *Aerobii* of Pasteur.

Thermic and Galvanometric Laws of the Electric Sparks Produced on the Complete, Incomplete, and Partial Discharge of Condensers.—Prof. Emilio Villari.—The following laws are laid down:—The galvanometric deviations produced by incomplete discharges are proportional to the quantity of electricity which produces it. The heat caused by the sparks generated on an incomplete discharge is proportional to the quantity of electricity which produces it.

Vapours Diffused within Liquids.—S. Cantoni.—An extensive and mathematical paper, not admitting of useful abridgment.

Corundiferous Felspar of Biellese.—S. Sella.—The composition of this mineral is:—

Alumina	93·725
Ferric oxide	1·094
Silica, with titanic acid	3·141
Lime	traces
Water	0·867
	98·827

Singular Decomposition of Hydrochlorate of Phenyl-ethyl-amin.—M. Fileti and A. Piccini.—Noticed under *Gazzetta Chimica Italiana.*

On Digallic Acid and on the Alleged Artificial Tannin.—Dr. Freda.—Also noticed under *Gazzetta Chimica Italiana.*

Certain Derivatives of Santonin.—G. Carnelutti and S. Cannizzaro.—By boiling santonin with hydriodic acid and phosphorus a powerful monobasic acid is produced, to which the authors give the name of the santonosic.

A New Isomer of Santonin.—S. Cannizzaro and L. Valenti.—The compound, on treatment with a boiling solution of caustic potassa, is transformed into a meta-santonate.

Chemico-microscopic Researches on Ashes from Etna, falling at Reggio in Calabria, May 28, and on Lava collected at Giarre, June 2.—S. Cossa.—Not suitable for abstraction.

Temperature of the Voltaic Arc and its two Polar Extremes.—S. Rosetti.—The temperature of the positive pole is greater than that of the negative. The extreme point of the former has a temperature of about 4000°, whilst the corresponding negative point scarcely exceeds 3000°.

Gazzetta Chimica Italiana.

Anno ix., 1879. Fasc. 6 and 7.

Tungsten Chlorides and Oxychlorides.—Ugo Schiff.—By the action of phosphorus chloride upon tungstic anhydride there are formed in the first reaction oxychlorides, and especially oxy-tetra-chloride. These oxychlorides to an elevated temperature or pressure, and to the action of an excess of phosphorus chloride, pass into hexachloride, which is then partially decomposed into chloride and penta-chloride.

Process for the Economical Preparation of Bibasic Quinine Citrate.—F. Dotto-Scribani.—The author dissolves in three litres of boiling water acidified with 3·669 grms. monohydrated sulphuric acid, 100 grms. bibasic quinine sulphate, and adds to the solution 32·685 grms. of tribasic calcium citrate.

Researches on Satureia Juliana.—Dr. P. Spica.—This plant is used by the country people in some parts of Italy as a remedy for intermittents. The author has extracted from it a non-nitrogenous principle, to which he assigns the formula $C_{35}H_{56}O_4$.

Chemical Study on the Salts from the Mother-liquors of the Saline Springs of Volterra.—Dr. A. Funaro.—The author has examined these waters as a commercial source of the salts of potash.

Analysis of a Chrysocolla from Chili.—Niccolo Pelegrini.—In different portions of the ore the oxide of copper ranges from 31·913 to 65·306 per cent.

Singular Decomposition of the Hydrochlorate of Phenyl-ethyl-amin.—M. Fileti and A. Piccini.—The hydrochlorate of phenyl-ethyl-amin if heated in a small tube sealed at the lamp undergoes a decomposition; on opening the tube there is not the slightest escape of gas, but there is perceived a slight odour of an aromatic hydrocarbon, and there is formed a hydrochlorate less soluble in water than the original substance. If the temperature is raised to 270° to 280° the quantity of the sparingly soluble hydrochlorate decreases, but the aromatic odour is stronger, and on adding water oily drops are separated.

Certain Neutral Ammoniacal Salts.—Fausto Sestini.—The salts in question are the citrate, phosphate, and photo-santonate.

New Experiments on Resins.—Giacomo Luigi Ciamician.—Abietinic acid and colophonium distilled with zinc powder yield toluol, meta-ethyl-toluol, naphthalin, methyl-naphthalin, and methyl-anthracen. Resin of elemi distilled in the same manner produces toluol, meta- and para-methyl-ethyl-benzin, and ethyl-naphthalin. Gum ammoniacum similarly treated gives very different products, one of the principal being $C_{13}H_{20}$, a hydrocarbon of the benzol series. It is probable that all the resins which resist the action of fused caustic potash are decomposed on reduction with zinc powder into hydrocarbons belonging to the naphthalin series.

Isomeric Nitro-salicic Acids.—Ugo Schiff and F. Massino.—Not adapted for abstraction.

Alleged Artificial Tannic Acid.—Dr. Pasquale Freda.—By the action of arsenic acid, gallic acid, whether in alcoholic or aqueous solution, is not transformed into digallic acid, but into an arsenical compound having some of the properties of tannic acid. If this compound is freed from arsenic by means of hydrogen sulphide the gallic acid reappears unaltered.

On Piperidin.—R. Schiff.—A short notice of some bromine derivatives of this base.

Action of Potassium Cyanide upon the Ammoniacal Derivatives of Chloral.—R. Schiff and S. Speciale.—The compounds thus submitted to the action of potassium cyanide are chloral-ammonium, chloral-acetamid, and chloral-benzamid.

Crystalline Form of Anglesite from Sardinia.—Quintino Sella.—Upwards of seven pages of figures and crystallographic formulæ.

Crystalline Form of Certain Substances of the Aromatic Series.—Dr. R. Panebianco.—Incapable of abstraction.

Lithofellic Acid and Certain Lithofellates.—Dr. G. Roster.—An account of the preparation of lithofellic acid and of its sodium and barium salts, with particular notice of their crystalline forms.

Researches on the Lavas of the Volcanoes of Ernici in the Valley of Sacco.—S. Speciale.—The lavas contain alumina, magnesia, lime, potash, soda, ferrous and ferric oxides, traces of copper, silica, phosphoric acid, and traces of carbonic acid with water, besides imponderable traces of manganese, and of barium and lithium, visible with the spectroscope.

Detection of Nitric Acid in Presence of Nitrous Acid.—A. Piccini.—The substance is dissolved in water along with a good quantity of urea, and the solution is added little by little to another solution of urea in dilute sulphuric acid. When the decomposition is complete some iodurетted starch paste is added. If the colourless liquid takes a blue colouration on the addition of a fragment of zinc, this indicates the presence of nitrates.

La Correspondance Scientifique.

No 61, September 23, 1879.

Sophistications of Olive Oil.—The adulteration of this oil has become so prevalent that the Minister of *Agriculture and Commerce* has requested the Academy of Sciences to ascertain the most trustworthy method for the detection of such frauds. Among the procedures at present under examination by a special committee is the use of the diagometer, an instrument devised by Prof. Luigi Palmieri, founded on the difference of the electric conductivity of oils. Seed oils are as a class better conductors than olive oil. At the same time every oil conducts the better the greater are its impurities. Linseed and cotton seed oil are among the best conductors, whilst the oils of pine seeds and of hazel nuts are almost as feebly conductive as the purest olive oil, known in commerce as virgin oil. Fortunately these two oils are too rare and costly to be used in the adulteration of olive oil. The use of the diagometer requires considerable manipulative skill.

Reimann's Färber Zeitung,

No. 35, 1879.

At a recent meeting of the Berlin Dyer's Association the new colour, "Puteaux blue," manufactured by MM.

Patry, of Puteaux, came under discussion. It was considered to be in all probability an indulin, but was pronounced not well adapted for wool-dyeing. For mixed colours upon silks, and as a ground for blues it was said to be applicable. Dr. Reimann, in speaking of "pittacall blue," considered that at no very distant period the products of beech tar would be utilised for the production of artificial tannin.

The "Weighting" of Silks.—Marius Moyret.—The system of weighting is ruinous to the silk-growing departments of France. Their high-class products are no longer in demand, as inferior and cheaper foreign silks serve equally well for loaded tissues. Hence these districts, already suffering from the phylloxera and from the loss of the madder trade are in the utmost distress. The author proposes that in the sale of silks, as in that of gold and silver, the proportions of the real article and of weighting matters should be exactly specified, and that a central office for the cheap and rapid assay of silks should be opened in Lyon. He states that the most excessive weighting has been carried out by a New York firm.

MISCELLANEOUS.

Lightning Conductors.—The delegates nominated in 1878 by the Royal Institute of British Architects, the Society of Telegraph Engineers, the Physical Society, and the Meteorological Society, "To consider the possibility of formulating the existing knowledge on the subject of the protection of property from damage by electricity, and the advisability of preparing and issuing a general code of rules for the erection of Lightning Conductors," have already collected a large amount of thoroughly practical information. Being anxious, however, that their Report should be as trustworthy and as exhaustive as possible, they invite correspondence upon the following points:—Full details of accidents by lightning, stating especially whether the building struck had a conductor or not. If there was a conductor, state its dimensions, construction, mode of attachment to the building, whether its top was pointed, distance of its upper terminal from the place struck, nature and extent of the connection between the conductor and the earth, and whether the earth was dry or moist, whether the conductor was itself injured, and whether the conductor or the point struck was the most salient object in the vicinity. Information is also desired, either verbally or by sketches, as to the position of metal spouting and lead roofing relatively to the point struck, and to the conductor. Details of the thickest piece of metal melted by a flash of lightning are much needed. Unimpeachable evidence of the failure of conductors is much desired, as such failures would be extremely instructive. The Secretary to the Conference is Mr. G. J. Symons, F.R.S., 30, Great George Street, S.W.

Sanitary Institute of Great Britain.—The Proceedings of the Autumn Congress of the Sanitary Institute, which will be held at Croydon, will be as follow:—Tuesday, October 21, 1 p.m., Public Luncheon; 3 p.m., Opening of Exhibition; 8 p.m., First General Meeting, Opening Address, by Benjamin W. Richardson, M.D., F.R.S., President of the Congress. Wednesday, October 22, Section I., "Sanitary Science and Preventive Medicine;" Address by Alfred Carpenter, M.D., President of the Section; Papers and Discussions, on "Sanitary Science and Preventive Medicine;" 8 p.m., Conversazione. Thursday, October 23, Section II., "Engineering and Sanitary Construction;" Address by Captain Douglas Galton, R.E., C.B., F.R.S., President of the Section; Papers and Discussions, on "Engineering and Sanitary Construction; 8 p.m., Lecture to the Congress, by Prof. W. H. Corfield, M.D. Friday, October 24, Section III., "Meteorology and Geology;" Address by G. J. Symons, F.R.S., President of the Section; Papers and Discussions, "Meteorological, Geological, and Geographical; 5 p.m., Closing General Meeting of Congress; 7 p.m., Public Dinner. Saturday, October 25, Excursions. The Lectures to the Congress and the General Meetings will be held in the Large Public Hall, and the Sectional Meetings in the Small Hall adjoining. The Exhibition will be held in a Marquee erected at the Central Croydon Station, and will remain open until Saturday evening, November 8.

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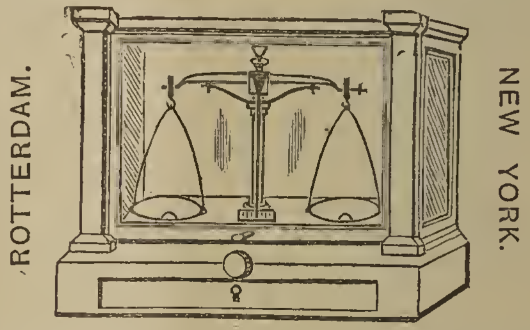

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THE CHEMICAL NEWS.

Vol. XL. No. 1039.

AGRICULTURAL CHEMISTRY IN JAPAN.

By ROBERT WARINGTON.

In the International Exhibition, now being held at Sydney, a collection of soils, manures, and agricultural products is shown by the Imperial College of Agriculture in Tokio, Japan. Accompanying the collection is a descriptive catalogue, compiled by Mr. Kinch, the Professor of Chemistry at the College, in which a short account is given of the various products exhibited, with chemical analyses of the majority of them. The catalogue contains in all about 80 analyses of Japanese products. The whole of this important work has been accomplished in the laboratory of the College, under the superintendence of Mr. Kinch, and is certainly highly creditable to the Institution. We propose to select from this Japanese chapter in agricultural chemistry some of the results which appear to have a special interest.

The catalogue opens with some analyses of soil. Then follow analyses of manures, including lime, wood ashes, nitre, waste vegetable substances, and residues from various manufactures, fish manure, bone, superphosphate, bird's dung, and hair. Next in order come analyses of foods.

Rice.—This is the grain principally cultivated in Japan. The composition of ordinary rice, and of the glutinous rice used in preparing the New Year's cakes, is as follows:—

	Ordinary Rice.	Glutinous Rice.
Water	13·63	12·01
*Albuminoids	5·80	5·13
Fat	2·15	3·30
Starch, &c.	73·14	73·20
Fibre	4·00	4·91
Ash	1·28	1·45

Mr. Kinch remarks that other specimens of Japanese rice gave 11·0 to 14·0 per cent of water, 6·07 to 7·77 per cent of albuminoids, and 1·08 to 1·33 per cent of ash.

Soy Bean (*Glycine* [*Soja*] *hispida*).—This bean is remarkable for containing a very high percentage both of albuminoids and fat: it forms probably the most concentrated food furnished by the vegetable kingdom.

	White Soy Bean.
Water	11·32
Albuminoids	37·75
Fat	20·89
Starch and soluble cellulose	24·58
Fibre	1·50
Ash	3·86

A variety of foods and condiments are prepared from this bean. By mixing the boiled beans with fermenting rice and some salt, and allowing the whole to stand in a cool place for a month, the food known as *Miso* is prepared. By precipitating the watery extract of the boiled beans with common salt, a crude legumin rich in fat is manufactured; this is known as *Tofu*.

Shoyu, known in this country as Soy, is made by a complicated process from soy beans and wheat. These ingredients are roasted, then mixed with fermenting wheat, and kept for some days in a warm room till covered with a fungus. The mass is then extracted with a solution of common salt, and the mashing preserved in vats for three or five years. It is then filtered for use, honey or fermented rice being sometimes added if a sweet soy is desired.

Sweet Potato (*Batatas edulis*).—The tubers were found to have the following composition:—

	White Variety.	Red Variety.	Red Variety.
Water	75·50	75·20	69·10
Albuminoids ..	1·02	0·92	0·84
Fat	0·29	0·26	0·39
Sugar	5·19	5·82	8·42
Starch, &c.	15·52	15·13	15·81
Fibre	1·39	1·32	4·37
Ash	1·09	1·35	1·07

Large Radish.—One of the principal root crops in Japan consists of a giant radish, *Raphanus sativus*. No. 1 root was 30 inches in length, and weighed 3·65 kilos.; No. 2 was rather smaller:—

	No. 1.	No. 2.
Water	94·97	94·45
Albuminoids	0·57	0·64
Soluble carbo-hydrates	3·25	4·33
Fibre	0·60	
Ash	0·61	0·58

Bamboo Shoots.—The underground buds of the root stock of the bamboo are frequently employed as food; they also serve for making pickles. Two principal kinds had the following composition:—

	Large variety.	Small variety (more mature).
Water	90·21	91·79
Albuminoids	3·28	2·59
Fat	0·13	0·11
Sugar	1·93	0·10
Extractive matter	2·54	2·81
Fibre	0·90	1·10
Ash	1·01	1·10

Seaweeds.—A list is furnished of a large number of edible seaweeds, and analyses of many of them are given. Laver (*Porphyra vulgaris*) is cultivated in the neighbourhood of Tokio. Branches of oak are placed in the shallow water of the bay in spring-time; on these the laver appears, and is collected from October to the following March, after which the plant becomes too hard to be of use. This seaweed flourishes best in brackish water. With the following analyses of Laver the market price of each is mentioned; it will be seen to follow pretty closely the percentage of nitrogenous matter, which is greatest in the young plant.

	Best.	Medium.	Common.	Purple.		Pale Green.
	Price 36 sen.	Price 29 sen.	Price 3 sen.	Price 27 sen.	Price 18 sen.	Price 5 sen.
Water	14·40	12·60	19·40	12·98	12·91	15·61
Nitrogenous substance	26·14	18·11	4·48	17·41	19·88	6·32
Extct. matter	44·51	56·83	57·71	51·10	48·59	52·63
Fibre	5·50	5·66	7·46	9·83	9·98	8·71
Ash	9·45	6·80	11·90	8·68	8·64	16·73
	100 *Parts of the Ash contained*—					
Potash	34·50	31·50	11·15	35·19	33·83	32·27
Phosphrc acid	14·07	13·77	6·05	13·27	14·16	7·25
Silica	1·40	0·60	7·80	6·40	6·65	1·96

Analyses of Tangle (*Fucus saccharina*), and of other edible seaweeds, are given below. From the *Gelidium corneum* the Kanteen, or vegetable isinglass, is prepared. The cleaned plant is boiled with water, the solution is strained, and allowed to set to a jelly in wooden boxes. The jelly is cut into long prisms, frozen, and then allowed to thaw in the sun. The water runs away as thawing proceeds, leaving a white skeleton of kanteen. One part will make a firm jelly with 150 of water.

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* The albuminoids in all these analyses are found by multiplying the nitrogen by 6·33.

	Enteromorpha compressa.	Capea elongata.	Cystoseira sp.	Alaria pinnatifolia.	Fucus saccharina.		Vegetable Isinglass.
Water	13·60	13·17	16·40	15·11	26·80	24·82	22·80
Nitrogenous substance ..	12·41	8·99	8·42	8·29	7·79	6·02	11·71
Extractive matter	52·99	45·09	41·92	40·62	33·58	45·66	62·05
Fibre	10·58	7·40	17·06	2·16	9·33	4·97	—
Ash	10·42	24·74	16·20	33·82	22·50	18·53	3·44

100 *Parts of the Ash contained.*

Potash	27·98	—	32·55	21·00	27·00	31·77	—
Phosphoric acid –	11·22	2·37	2·20	2·61	4·43	2·96	—
Silica	6·97	2·20	1·91	trace	3·94	trace	—

Tea.—Three analyses of Japanese tea are given, two prepared by native methods, and one after the Chinese plan. 100 parts of tea contained :—

	Hiki-cha.	Sen-cha.	Chinese preparation.
Water	6·74	6·10	8·92
Soluble in Water ..	43·26	52·55	36·50
Tannin	12·50	12·10	13·19
Fibre	11·20	11·70	—
Ash	6·53	6·10	5·26
Nitrogen	5·79	6·38	3·18

Chrysalises.—The chrysalises of silkworms are used as food for fish, and also as manure. Two kinds contained as under :—

	Bombyx Mori.	Bombyx Yama-mai.
Water	10·99	9·28
Nitrogenous substance	47·28	49·75
Fat	14·83	23·57
Ash	3·24	2·54

Starch and Sugar.—Starch is prepared in Japan from buck-wheat ; from the common brake, *P. aquilina* ; from the root of a leguminous plant, *Pueraria Thunbergiana* ; and from the root of a lily, *Erythronium grandiflorum.*

Starch-sugar is prepared by treating steamed rice with a portion of rice, wheat, or barley which has already undergone fermentation. After digestion for several hours at a fixed temperature the solution is strained, and evaporated either to a syrup or to a solid condition. The solid sugar contains 7 to 11 per cent of water. Both maltose and dextrin are present.

Alcoholic Liquors.—Rice-beer (*Sake*) is the most important beverage of the country. It is manufactured only during the winter months. The ferment is first prepared by spreading steamed rice mixed with wood-ashes in shallow trays, which are then seeded with the yellow spores of the fungus developed in a previous operation, and kept for some days in a warm chamber. When the fungus has developed, the mass is used to inoculate a fresh quantity of steamed rice. The mash is prepared by adding to steamed rice and water a certain proportion of the above ferment, and the whole is repeatedly agitated for two days. In this stage of the operation the starch of the rice is converted into sugar. The mash is then transferred to a large vessel, and the temperature raised to that of the human body. In this stage an active alcoholic fermentation takes place. The liquor thus formed is not, however, the final product. To it are added fresh quantities of steamed rice, water, and ferment, and after three days mashing this addition is again, and yet again repeated. When the last rice has been added the whole is allowed to ferment for thirteen days. The *sake* is now strained, and the residue pressed. After standing fifteen days to clear, the pure *sake* is heated to 120° F. to destroy any remaining yeast, and is then fit for use.

Finished *sake* contains, according to six analyses given by Mr. Kinch, 11·33 to 15·0 per cent of alcohol by weight, and 2·33 to 3·05 per cent of solid matter ; the total free acid, reckoned as acetic, was 0·20 to 0·27 per cent. Various sweet, imperfectly fermented, liquors are also manufactured. The solid residue left after pressing out the *sake* is distilled, and yields spirit of various strengths. The strongest spirit exhibited was 10·7 over Proof.

After the description of Japanese foods comes a summary of the dyestuffs used. Many of these are rapidly giving way to the brighter aniline colours.

The methods of preparing indigo and safflower are given in some detail. The six specimens of indigo exhibited contained from 10·91 to 19·3 per cent of pure indigotin.

The various oils and waxes of Japan form the concluding section of the catalogue. Vegetable wax is largely used for candles ; it is prepared from the berries of the *Rhus succedanea.* The berries are collected in autumn, dried a few days in the sun, and then stored for several years. When taken for use they are crushed, steamed, and pressed while hot : a dark green wax is thus obtained, amounting to 15 per cent of the original berry. The wax may afterwards be purified and bleached.

A NEW QUANTITATIVE ANALYTICAL METHOD OF EXTENSIVE APPLICABILITY.

Prof. A. Classen has extended his method of separating zinc from manganese, ferric oxide and alumina from manganese, and of determining cobalt and nickel, so that it is now applicable, not merely to the estimation of single constituents of complex bodies, but of all the ingredients present. The following summary of his process is taken from the *Zeitschrift für Analytische Chemie* :—

The determination of magnesium and its separation from the alkalies is effected by adding to the aqueous solution, whose volume should be about 25 c.c., a hot saturated solution of ammonium oxalate, or by dissolving in it solid ammonium oxalate with the aid of heat ; boiling, adding an equal volume of acetic acid at 80 per cent, maintaining the mixture at a boil for some minutes with constant stirring, allowing to stand for six hours at 50°, filtering, and washing the precipitate with a mixture of equal volumes acetic acid, alcohol, and water. The precipitate and filter, still moist, are heated to dryness in a covered crucible, at first very gently, then with access of air, but with a small flame till the carbon is consumed, and finally strongly ignited, when the magnesium oxide is weighed. The latter is dense and heavy, and no loss is to be apprehended on ignition. In order to separate magnesium from the alkalies the oxalate must be precipitated from more dilute solutions, otherwise a double oxalate of magnesium and potassium is formed and is not decomposed by the subsequent treatment, whence the magnesium oxide is contaminated with potassium carbonate. The liquid, about 50 c.c., is therefore mixed with a cold saturated solution of ammonium oxalate (1 : 24), and ⅓ vol. of alcohol is added. The magnesia thus prepared contains no potassium, or mere spectroscopic traces, and the precipitation of the magnesium is complete. The process is applicable whether the alkalies are present as chlorides, sulphates, or nitrates.

For the complete precipitation of manganese oxalate, Classen adds zinc chloride ; in cases where the presence of zinc would be inconvenient, he uses magnesium chloride, in such quantity that for each mol. of manganic oxide at least 1 mol. magnesia must be present, otherwise the residue after ignition is a mixture of manganic and manganoso-manganic oxides. For determining the zinc oxide the solutions are freed from all uncombined acid by evaporation in the water-bath, and in case of sulphuric acid by subsequent heating in the sand-bath; the residue is moistened with a few drops of dilute nitric acid, or digested for a short time with about 10 c.c. bromine water. A sufficient quantity of neutral potassium oxalate (1 : 3), about seven times the weight of the oxide, is added, the mixture is heated in the water-bath, and the ferric oxide is dissolved by the addition of acetic acid in drops. The whole is then heated to a boil, an equal volume at least of acetic acid is added, and after standing for six hours it is filtered while still warm, washed with the mixture of acetic acid and alcohol, and the zinc oxalate is ignited. Nickel and cobalt are determined in a similar manner; the washed oxalates are ignited, washed again, and re-ignited. The oxalate of nickel is precipitated in a crystalline state only when in small quantity, wherefore it is prudent to take only small quantities of the substance for analysis. Cobalt oxide is reduced in a current of hydrogen and weighed as metal.

Copper oxalate, if precipitated in the manner described for zinc and manganese, falls in a state of very fine division and settles badly. The determination is accurate and convenient if a sufficient quantity of potassium oxalate is added to the neutral concentrated solution. After a time the greater part of the copper separates in fine blue acicular crystals as cupro-potassic oxalate, and on adding an equal volume of acetic acid and allowing the liquid to stand, the residue of the copper is completely precipitated. The precipitate, after washing, is gently ignited, lixiviated, and re-ignited till the weight becomes constant, or, as Classen prefers, dissolved in dilute sulphuric acid, and the copper determined electrolytically by means of a thermo-battery, or two Bunsen elements. In presence of antimony and arsenic chloride along with iron, as in the analysis of fahl-ores, the copper is not completely separated by the process above described, not even on the addition of zinc or magnesium chlorides. If but little antimony is present the substance is dissolved in nitric acid, the solution evaporated to dryness, the residue mixed with potassium oxalate in excess, filtered while hot, washed with a little water containing potassium oxalate, and the filtrate concentrated to 50 c.c. In presence of larger proportions of antimony the substance, finely pulverised and mixed with 4 parts ammonium chloride, is very gently ignited in a covered crucible, and thus almost all the arsenic and antimony, together with the greater part of the iron, are driven off as chlorides. The copper is then determined as above.

The separation of phosphoric acid from such oxides as form with potassium oxalate soluble double salts, capable of being decomposed by acetic acid, *e.g.*, lime, is effected by the separation of the oxalates as described above. Ferric oxide and alumina, whose oxalates form with potassium oxalate double salts not decomposable by acetic acid, are completely eliminated by means of alcohol. The phosphate is dissolved in hydrochloric acid, evaporated to dryness, mixed with potassium oxalate six times the weight of the oxides, and digested for a short time in the water-bath, the ferric oxide dissolved by acetic acid and the same acid in excess and alcohol at 95 per cent are added as long as a precipitate is formed. After standing for six hours the precipitate is filtered, washed with alcohol, the filtrate in the beaker concentrated on the sand-bath to expel acetic acid and alcohol, the residue almost dry is diluted with water, any silica which separates is filtered off, and the phosphoric acid precipitated by means of ammonia and magnesia mixture. The process is suitable for the determination of phosphorus in crude iron. Arsenic acid behaves like phosphoric acid. Salts of cobalt, nickel, and zinc do not retain arsenic.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. VIII.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(Concluded from page 188.)

6. (51.) *Examination of the Constitution of Antimonic Acid prepared by Different Methods.* By C. P. Conrad, of Winchester, Virginia.

According to Berzelius,* antimonic acid, obtained by acting upon metallic antimony with nitric acid or aqua regia, or by precipitating an antimoniate by an acid, has the composition $Sb_2O_5.H_2O$ (found 5·09 per cent H_2O, calculated 5·32: atomic weight of Sb taken = 120).

According to Fremy† the product thus obtained is $Sb_2O_5.5H_2O$ if dried in a stream of dry air at ordinary temperature (found 21·7 per cent H_2O, calculated 21·95), this being his antimonic acid; while he found his metantimonic acid, obtained by the action of water on antimony pentachloride, to consist of $Sb_2O_5.4H_2O$ (found 17·1 per cent H_2O, calculated 18·37). More recently Geuther‡ states that by precipitating a solution of potassium antimoniate with nitric acid, washing the precipitate, and leaving it to itself during a whole summer, he obtained a hydrate having the composition $Sb_2O_5.3H_2O$, which when heated to 175° gave off 2 molecules of water and became $Sb_2O_5.H_2O$. And Daubrawa§ says that by decomposing antimony pentachloride with water he prepared an antimonic acid which, dried in the air, had the composition $Sb_2O_5.4H_2O$; dried over sulphuric acid, became $Sb_2O_5.3H_2O$; at 100° became $Sb_2O_5.2H_2O$; at 200° $Sb_2O_5.H_2O$; at 275° the anhydrous pentoxide, Sb_2O_5; and above 300° began to lose oxygen and become Sb_2O_4.

In view of this discrepancy of statement as to the constitution of the antimonic hydrate or hydrates, Mr. Conrad undertook the experiments now reported.

Commercial metallic antimony, found to contain a small quantity of iron and traces of lead, tin, and copper, was purified by fusion with one-twelfth its weight of sulphur, oxidation of one-fifth the remaining metal by means of nitric acid, and fusion of the oxide so obtained with the other four-fifths of metal, this purification being repeated as often as was found necessary. The metallic buttons were cleaned on the outside by washing in acid and water.

From this pure metal antimonic acid was prepared by the following methods:—

A.—Action of fuming nitric acid in excess, adding further amounts of acid several times, and evaporating finally on a water-bath until no trace of acid vapour could be detected by litmus paper.
B.—Action of strong aqua regia, followed by evaporation with successive additions of strong nitric acid.
C.—Decomposition of neutral potassium antimonate (prepared as directed by Fremy) by hydrochloric acid.
D.—Decomposition of acid potassium metantimonate (Fremy) by hydrochloric acid.
E.—Decomposition of neutral potassium metantimonate (Fremy) by hydrochloric acid.
F.—Decomposition of antimony pentachloride by excess of water.
G.—Decomposition of antimony pentachloride by excess of a weak aqueous solution of ammonia.

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[*] "Traité de Chimie" (Paris, 1830), ii., 499.

[†] *Ann. de Chim. et de Phys.*, [3], xxiii., 404.

[‡] "Jenaische Zeitschrift," vii., 121, quoted in "Watts's Dictionary," 2nd Suppl., 98.

[§] *Ann. d. Chem u. Pharm.*, 186, 110.

It appeared to be impossible to obtain by the first method (A) a product free from Sb_2O_4. At any rate, in all the specimens actually prepared auric chloride revealed the presence of the lower oxide, and in one case a volumetric determination—by means of potassium pyrochromate, &c.—showed its amount to be equivalent to 20·86 per cent of Sb_2O_3, or 44·04 per cent of Sb_2O_4. No use, therefore, was made of the material prepared by (A).

Some of the products of (B), (F), and (G) also proved to contain antimonoso-antimonic oxide [Sb_2O_4, or $Sb(SbO_4)$], to the formation of which there is clearly a very strong tendency; but specimens of antimonic acid quite free from this were made by all the processes save (A). In each case the product was very carefully washed, and the absence from the material taken for analysis of nitric acid, chlorine, potassium, and ammonium was established. In purifying (G) it was found necessary to wash at first with weak nitric acid.

In analysing the various specimens of antimonic acid, the antimony was determined (to avoid any uncertainty as to the character of the oxide present) in one portion by dissolving in a minimum of strong hydrochloric acid, adding tartaric acid, diluting largely, precipitating with hydro-sulphuric acid, heating for two or three hours while carbon dioxide was passed through the liquid, filtering on a weighed filter, drying to constant weight in a steam-bath, transferring most of the contents of the filter to a porcelain boat, placed in a hard glass tube through which a stream of carbon dioxide was passed, and gradually raising the temperature to redness so as to expel all traces of moisture and free sulphur; the true weight of the whole precipitate being calculated from that of the part thus purified. In a second portion of the same antimonic acid water was determined by exposure over sulphuric acid (in some instances at once in a steam-bath), and noting loss of weight; and afterwards by exposure to a slow stream of pure perfectly dry nitrogen at various determinate, progressively increased temperatures, the water driven off being collected in a chloride of calcium tube, and the loss of weight of the antimonic acid noted in comparison, so as to ascertain when reduction by heat to the lower oxide began. The remaining oxygen of the antimonic acid was obtained from the difference between the total weight and that of the antimony *plus* water. Preliminary experiments were made by this method upon pure, more or less hydrous, antimonious oxide with a view to practice, and to prove that trustworthy results could be obtained.

The loss of water was found to occur very gradually, and appeared to be influenced by the rapidity as well as temperature of heating. The results, however, point distinctly to $Sb_2O_5.3H_2O$ as the composition of the acid dried in air at ordinary temperature and pressure over sulphuric acid, 14·53, 15·28, 14·45, and 14·11 per cent of water being found for 14·44 calculated. A larger, more variable, and more loosely retained (perhaps merely hygroscopic) amount of water was, in addition to this, found in the acid dried by simple exposure to air at mean temperature before placing it over sulphuric acid, making the largest amount found approximate to the $5H_2O$ of Fremy (21·16 to 19·12 per cent instead of 21·95 calculated).

For the samples dried at 100° C. the amount of water retained corresponded generally with $Sb_2O_5.2H_2O$: thus, 11·30, 11·44, 11·37, and 11·06 per cent were obtained instead of 10·11 calculated. This was verified by converting a known weight of pure metallic antimony into antimonic acid (by means of aqua regia), drying at 100°, and weighing. The result corresponded to 66·87 per cent of Sb in the product instead of 67·42 calculated for $Sb_2O_5.2H_2O$. But this point of temperature does not sharply mark the retention of this exact proportion, since figures as low as 8·95 and 8·77 per cent H_2O were in some cases observed. The temperature of commencing decomposition of $Sb_2O_5.2H_2O$ may fall below 100°.

Between 100° and 200° another molecule of water was given off, and $Sb_2O_5.H_2O$ formed; but it is clearly not easy to fix a precise temperature, at any rate without reference to other conditions, at which this hydrate either shall be obtained as a stable compound.

Finally, the statement of Daubrawa that the anhydrous pentoxide is produced at 275° was not verified. Even after prolonged exposure to a temperature of 300° as much as 2·74 per cent of water (about half a molecule) was found to be retained, and could only be completely expelled at a low red heat, when oxygen was also lost and Sb_2O_4 began to be formed.

The series of specimens examined was not quite complete, owing to one or two analyses having been lost, and not sufficient material being on hand for their repetition; but there was no indication of any inherent difference of composition in the acids prepared by the various methods, and Fremy's statement under this head in regard to free antimonic acid failed of verification.

On the whole, there seems to be sufficient reason for believing in the existence of three antimonic acids corresponding with the three chief hydroxylic acids of phosphorus, and it will conduce to clearness if the nomenclature be made to agree with that of these latter. Thus we shall have—

H_3SbO_4, or $3H_2O.Sb_2O_5$, Ortho-antimonic acid.
$H_4Sb_2O_7$, or $2H_2O.Sb_2O_5$, Pyro-antimonic acid (Metantimonic acid of Fremy).
$HSbO_3$, or $H_2O.Sb_2O_5$, Metantimonic acid (antimonic acid of Fremy).

The so-called acid antimonates and metantimonates of Fremy, if not containing basic hydrogen, are of course not true acid, but anhydro-salts, compounds of the normal salts with antimony pentoxide. The gradual, rather than sudden, transition on heating from the first of these metallic acids to the second and third finds a parallel in the corresponding case of the acids of phosphorus; and the similarity of behaviour of the latter even extends in some degree to the final production of the anhydrous oxide, since H. Rose has observed that when meta-phosphoric acid is volatilised the last portions are mixed with phosphorus pentoxide. In the case of antimony there is a notable tendency, both in the production of the acids and in their decomposition by heat, to partial loss of oxygen and formation of ortho-antimonate of antimony, $Sb(SbO_4)$ or Sb_2O_4, the well-known neutral oxide of the metal.

7. (52.) *On the Mutual Relations, in Aqueous Solution, of Potassium and Sodium Alums.* By F. P. Venable, of Charlottesville, Va.

Two forms of isomorphism between these salts are conceivable, viz., (*a*) the replacement in potassium alum of one out of the two atoms of potassium by sodium, or reciprocally as to sodium alum, giving rise to a salt of the constitution—

$$\left.\begin{matrix}K\\Na\end{matrix}\right\}Al_2(SO_4)_4.24H_2O,^*$$

which might be confidently expected to exhibit similarity of crystallisation to the two alums with a single alkaline metal each; and (*b*) the isomorphous admixture, in various proportions, of the ordinary alums themselves in individual crystals. If the formation of the double alkaline alum were possible, such a salt would most probably be capable of crystallising in all proportions along with either simple potassium or sodium alum, but as these two latter differ from each other greatly in solubility it was thought possible that some indication might be obtained of a tendency to the formation of the potassio-sodium alum by crystallisation, effected under various conditions of temperature, strength of solution, and relative proportion of the two simpler salts.

With a view to test this, perfectly pure potassium and sodium alums were prepared, free from ammonium salt, and their solutions were mixed in proportions varying from

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* It being assumed, on the strength of the experiments of Hertwig (*Pogg. Ann.*, lv., 99), Lupton (*Jour. Chem. Soc.*, [2], xiii., 201), and Heintz (*Pogg. Ann.*, iv., 331) that $M_2Al_2(SO_4)_4.24H_2O$, and not this formula halved, correctly represents the ordinary alums.

1 molecule of sodium alum for 1 of potassium alum to 25 mols. of the former for 1 of the latter. The mixed liquids were exposed to spontaneous evaporation for different periods, and at temperature ranging from 5° to 25° C., but no tendency could be traced to the uniform production, under any given set of conditions, of crystals containing 1 atom potassium for 1 of sodium. The isomorphous replacement seemed to be solely of the second or simpler kind (*b*), while the inferior solubility of potassium alum tended strongly to make this salt relatively predominant in the crystals separated.

In the course of these experiments it became apparent that, as in some of the cases, examined by Karsten* and Page and Keightley,† of mixed solutions of salts not acting chemically upon each other, the amount of each dissolved was diminished by the presence of the other, and as no results of this kind in regard to the alums seem to be on record, it may be well to quote the following table, giving the figures obtained for the effect on the solubility of potassium alum produced by the presence of various amounts of sodium alum. The several solutions of the latter were placed in contact with an excess of finely-crystalline potassium alum in closed flasks, allowed to stand for four days, with occasional agitation, and the clear liquid then drawn off and analysed. The temperature ranged from 13° to 16° C. Supersaturation, it is believed, was effectually guarded against.

Composition of 100 *c.c. of each Solution.*

	Water. Grms.	Sodium Alum. Grms.	Potassium Alum. Grms.
No. 1.	97·4	4·70	7·60
,, 2.	94·9	9·46	5·75
,, 3.	93·8	11·35	5·33
,, 4.	92·3	14·19	4·85
,, 5.	89·7	18·92	4·22
,, 6.	84·1	28·38	3·23
,, 7.	76·5	42·57	2·07
,, 8.	74·0	56·76 (sat.)	1·28

Or, expressing these results otherwise, 100 grms. of water, if already holding in solution the amounts of sodium alum noted in col. 2 of the following table, will dissolve at most the amounts of potassium alum given in col. 3.

	100 grms. of Water, Holding of Sodium Alum	will dissolve of	Potassium Alum
No. 1.	4·8 grms.		7·8 grms.
,, 2.	10·0 ,,		6·1 ,,
,, 3.	12·1 ,,		5·7 ,,
,, 4.	15·4 ,,		5·3 ,,
,, 5.	21·1 ,,		4·7 ,,
,, 6.	33·7 ,,		3·8 ,,
,, 7.	55·6 ,,		2·7 ,,
,, 8.	76·7 ,,		1·7 ,,

University of Virginia,
July 25, 1879.

ON A

POSSIBLE CAUSE OF VARIATION IN THE PROPORTION OF OXYGEN IN THE AIR.

By E. W. MORLEY, M.D., Ph.D.,
Professor of Chemistry in Western Reserve College, Hudson, Ohio.

(Concluded from page 186.)

When the writer planned to make analyses of air in order to detect if possible some law in its variations of composition, he expected to have to do with quantities but little larger than the errors of observations. Some thought was therefore given to the methods of keeping such errors as small as possible. It was hoped that if the probable error of a determination of oxygen with this apparatus was not larger than the probable error of the analyses made by Bunsen in January and February, 1846, the object of the analyses would be attained. Such analyses as those of Bunsen would abundantly serve to establish variations of the four hundredth part of the average amount of oxygen contained in the atmosphere. The writer expected to have commonly to do with such variations, and therefore computed the comparative accuracy of analyses of air made with the long eudiometer of Bunsen's experiments, and with the apparatus used in the present work. In the first analysis by Bunsen of the air of January 9th, the length of the column of gas in the eudiometer was in round numbers 840 millimetres, and its tension 510. The tension was determined by four readings, and the apparent volume of air taken by one reading. An error in the last reading would produce also an error of the same sign in the observed tension, so that these two errors are not independent. Their influence on the result is therefore computed by simply adding them; the other errors are independent of this joint error and of each other. And the influence of the four independent errors on the result is computed by taking the square root of the sum of their squares. If we repeat this computation for the different volumes and tensions of the second and third measurements, reerring all the probable errors to the volume of air first taken, and obtain the probable errors of the three measurements, we may obtain the probable error of the final result by adding the square of the first probable error to the squares of the third parts of the second and third; and taking the square root of the sum.

The probable error of a single reading of the level of the mercury in Bunsen's experiments is not given; but we may compare the two methods by assuming arbitrarily some probable error, provided that we assume the same error in both computations. The first column of the following table gives the influence of a probable error of one-tenth of a millimetre in a single reading in each of the three measurements of the analysis quoted from Bunsen.

In the measurement of a volume of gas with the Frankland and Ward or McLeod apparatus, the mercury is brought to that mark in the eudiometer tube which will give a suitable tension, and the height in the pressure tube at which the mercury stands is determined. An error in determining the volume of gas in the eudiometer tube involves an error of the same sign in the observed tension. If we add these two dependent errors we have one of the two independent errors affecting this mode of measurement, the other being the error probably made in determining the upper level of the mercury in the pressure tube. Adding the squares of these two and taking the square root, we have the probable error of a measurement with the apparatus. If we treat the second and third measurement in the same way, and compute the effect of these three probable errors on the final result, we get the numbers in the second column of the following table.

Probable errors of measurements of gas, and of final results, occasioned by a probable error of the tenth of a millimetre in each reading.

	In Analysis cited from Bunsen. Per cent.	With Frankland and Ward apparatus. Per cent.
In measurement of air taken	0·046	0·034
In measurement of air and hydrogen	0·050	0·042
In measurement after explosion ..	0·039	0·031
Probable error of result	0·051	0·038

It is obvious that with the same error probable in each reading, the use of the rapidly working apparatus involves no sacrifice of accuracy to convenience, as far as the conditions of *observation* are concerned.

To obtain the degree of accuracy needed for the present purpose, it is necessary to take account of the expansion of the mercury in the column which measures the pressure,

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* *Schrift d. Berl. Akad.*, 1841.
† *Jour. Chem. Soc.*, [2], x., 566.

and also of the linear expansion of the scale which measures the tension, and of the cubical expansion of the eudiometer tube. Since all these are at the same temperature with the gas to be measured, it is easy to prepare a table giving the correction not only for the expansion of the gas but also for the expansion of mercury, scale and eudiometer. Such a table, giving on a single page, for every tenth of a centigrade degree from zero to to thirty degrees, the logarithmic factor to be added to the logarithms of the observed volume and observed tension, makes the work of reduction very slight. Most tables of correction of the volumes of gas contain a logarithm to be subtracted; for convenience it should be additive; and five places of decimals should not be exceeded. Unless measurements can be made ten times more accurate than Bunsen's, five places of logarithms distinguish smaller differences than observation deals with; five places permit instant interpolation for hundredths of a degree, and a greater number waste time and possess no advantage whatever.

The eudiometer was calibrated by filling it with air-free water, and weighing the quantity expelled as the mercury rose to each successive mark of the graduation. This was done four times for each division; the probable error of a single determination was found to be 8·6 milligrammes of water. The results were all reduced to the temperature of melting ice. There were seventeen divisions in the eudiometer tube, now broken, which was used in all the analyses in this paper. The volume of gas to be measured was always brought to one of the two divisions which permitted measurement under the most favourable conditions, and its tension determined; it was then brought to the other division, and its tension again determined. Two independent measurements thus obtained eliminated the chance of error in identifying divisions on the scale, and also afforded the means of ascertaining the probable error of a measurement. In the analyses contained in this paper, the quantity of air taken was unfortunately limited by the circumstance that the collecting tubes at hand were small; the probable error of the results so far obtained is therefore much greater than is due to the care used in observing. In analyses made after the present month this mistake of judgment will be corrected. The mean quantity of air taken in an analysis so far has been 38·9 c.c. measured at zero and 760 millimetres. From 196 pairs of measurements it has been computed that the probable error of a single determination of volume is its 5800th part. Hence the probable error of a determination of oxygen in the air is the 7200th part, and the probable difference of two determinations on the same sample is the 5100th part. A second analysis was always made when the first showed a deficiency of oxygen. A comparison of the results will show whether the accuracy indicated by computation was obtained.* The writer has in hand an entirely new construction of the pressure tube, and some modifications of the optical appliances for reading the level of the mercury in the eudiometer tube, by which he hopes considerably to lessen this probable error.

The samples of air analysed were collected in the open country in glass vessels with due care as to admixture with the air from the collector's lungs, preserved over mercury, freed from carbonic acid, and exploded with hydrogen, of proved purity, obtained by galvanic decomposition of water. But some samples were collected in clean stoppered and capped bottles, and kept for a short time by inverting the bottle in the cap which had been filled with water. In this case the air was withdrawn for analysis with a Tœpler's mercury pump.

The table gives in the first column the date, in the second the mean temperature of the day at this place as determined by three observations. In the third, on the days when analyses were made, the hour of collecting the sample is given, fractions of hours being disregarded. In the last two columns are given the hundredths per cent found by analysis, the figures twenty and the decimal point being suppressed. The figures ninety-six, for instance, in this column mean 20·96 per cent of oxygen. Within the time covered by the analyses now published, there were several well marked great and sudden depressions of temperature, and the figures show the falling off in the proportion of oxygen in the air at these times to be as well marked as the depression of temperature. The deficiency is not proportionate to the depression of temperature; this could not be expected.

ANALYSES OF AIR,

Showing Deficiency of Oxygen attending Sudden Depression of Temperature.

Winter of 1878-1879.

Date.	Mean Temperature. F.	Hour of taking sample.	Oxygen.	
Dec. 28	—	4 P.M.	98	96
29	14·8			
30	19·3			
31	16·2			
Jan. 1	23·8			
2	7·6	4 P.M.	91	92
,,		10 P.M.	90	89
3	−7·2	9 A.M.	90	91
,,		1 P.M.	96	97
4	2·2			
5	7·7			
6	13·5	3 P.M:	97	
7	19·3			
8	26·4			
9	16·9			
10	9·6	10 A.M.	96	
11	20·6			
12	26·0			
13	27·9			
14	26·3			
15	25·8			
16	28·5			
17	29·1			
18	—			
19	15·9			
20	9·9			
21	26·0			
22	37·7			
23	28·3			
24	32·5			
25	32·4			
26	23·7			
27	44·9			
28	37·4	9 A.M.	96	
29	31·5			
30	—			
31	28·2			
Feb. 1	18·5	9 A.M.		96
,,		9 P.M.	94	94
2	19·8	9 A.M.	91	93
,,		9 P.M.	82	80
3	26·8			
4	28·1			
5	31·5			
6	28·3			
7	25·1			
8	28·5			
9	24·0			
10	32·7			
11	54·4			
12	26·5			
13	15·6			
14	5·8			
15	11·1			

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* The divergence of the second result of February 26th from the first is due to the fact that in the second analysis the hydrogen used was not pure. As none of the sample remained for a third experiment, the second result is given in confirmation of the first. But this pair of results should not be used in computing probable errors.

Date.	Mean Temperature. F.	Hour of taking sample.	Oxygen.	
Feb. 16	26·3	9 A.M.	95	
17	25·7			
18	24·1			
19	23·2			
20	18·9	6 P.M.	87	87
21	17·9			
22	—			
23	25·4			
24	21·5			
25	37·1			
26	22·3	3 P.M.	45	50
27	12·8	9 P.M.	77	80
28	24·1			
Mar. 1	38·7			
2	29·7			
3	34·3			
4	37·2			
5	35·9			
6	41·6			
7	34·1			
8	51·0			
9	61·8			
10	58·4			
11	54·4			
12	40·3			
13	39·4			
14	29·3			
15	22·8	9 A.M.	88	84
,,		9 P.M.	84	86
16	25·3	9 P.M.	92	92
17	24·5	9 A.M.	89	90
18	24·3			
19	28·7			
20	33·1			
21	32·3			
22	34·6			
23	31·7			
24	40·1			
25	30·1			
26	38·2			
27	35·1			
28	44·8			
29	45·9			
30	33·3			
31	31·9			
Apr. 1	33·7			
2	29·9			
3	{ 25 at 2 P.M. }	9 A.M.	77	79
,,		9 P.M.	85	87
4	27·1	9 A.M.	80	80
,,		9 P.M.	88	85
5	28·2	9 A.M.	77	77
,,		9 P.M.	86	82
6	39·4			

It may be said that these analyses were commenced in March, 1878, but in December of that year, a doubt was felt whether it was absolutely certain that in every case the air and hydrogen had been completely mixed before explosion. In test cases, the air and hydrogen had been permitted to diffuse into each other for eighteen hours before explosion, and the results were the same as in the usual course of analysis; but the analyses are not here given, although they contain only evidence perfectly agreeing with that here presented. In all the analyses here printed, the air and hydrogen were known to be thoroughly mixed; they were driven as rapidly as possible through a capillary tube twelve or twenty times. All made between the first and last dates of the table are given without selection, except that some were rejected for obvious instrumental errors.

The remarkable deficiency of oxygen observed on the 26th of February seems affected with no reason for doubt. On Sept. 16, 1878, two very careful analyses of the same sample gave 20·49 and 20·46 per cent of oxygen. On July 19, and Nov. 10, 1877, Jolly found 20·56 per cent. The *Neues Handworterbuch der Chemie*, i., 856, cites an analysis of air from the Bay of Bengal showing 20·46 per cent, one of air from near Calcutta, showing 20·39 per cent, and one of air from near Algiers, showing 20·41 per cent. That Jolly and the writer have found air almost as deficient in oxygen as the three last will lesson the probability that the air of the surface of the earth in the Torrid zone is normally poor in oxygen. One of the first cases of a supposed descent of cold air from an elevation mentioned by Loomis occurred in the warmer parts of this country. If his theory finds favour, and the writer's conjecture is correct, it will be presumed that the three samples cited in the *Handworterbuch* from the still warmer regions of the earth were taken in the midst of such a mass of cold air descending from, and retaining the composition of, the upper part of the earth's atmosphere.

The analyses here printed should not be used in determining the average composition of the air by combining analyses from all sources. Whether the writer's conjecture is correct or not, it has enabled him to select times for taking samples of air varying widely from the average; and to such times his analyses have been commonly limited, only occasionally including a sample of presumably normal air to serve as a check on the abnormal.—*American Journal of Science*, September, 1879.

NOTICES OF BOOKS.

Friction and Lubrication. Determination of the Laws and Coefficients of Friction by New Methods and with New Apparatus. By R. H. Thurston, Professor of Mechanical Engineering at the Stevens Institute of Technology. London: Trübner and Co.

This work, which bears as its second title the words "Lectures on Friction, Lubrication, and Lubricants," seems to be a very complete and useful monograph on an important subject. Our attention is naturally in the first place drawn to what may be called the chemical department of the treatise,—the account given of the various lubricants, of the properties on which their applicability depends, and of the methods by which their applicability is tested. This amounts substantially to an account of oils, their sophistications, and their commercial analysis. For an oil to be really trustworthy as a lubricant it must combine a number of properties; it should be not liable to ignition or decomposition at any temperature likely to be produced by friction; it must have no corrosive action upon metals, and should therefore be free from acidity; it should not clog or "gum" on prolonged exposure to the air—a requirement which excludes all the so-called "drying" oils; it must not be liable to congeal on exposure to cold; it should minimise friction and should possess a maximum power of carrying away and dissipating heat, so as to keep cool the surfaces to which it is applied. These are general properties required for all lubricants. The degrees of body and of fluidity preferred vary according to the character of the machinery in question. Some of these qualities are estimated by chemical experiments, whilst others can only be judged by mechanical treatment approaching as closely as possible to the conditions of actual practice. The genuine or spurious nature of a given sample of oil is another consideration on which Professor Thurston bestows no little attention. Here it must be remembered that the question of purity can only arise if an oil is sold under a name denoting its origin. If a dealer offers us, *e.g.*, olive oil, we have a right to object if the sample contains even a trace of an oil from any other source, and that quite irrespective of any appreciable deterioration arising from such admixture. But if the sample is offered merely as a lubricating oil, then, so long as its beneficial action is in fair proportion to its market-price, the purchaser suffers no wrong.

We fear that the methods here given for detecting the various constituents of a mixed oil, except in thoroughly experienced hands, will often fail of arriving at the whole truth. Such mixtures are often somewhat complex, and contain not merely two or three kinds of oil, but other substances in solution, some of them added for the express purpose of masking reactions. Again, not only do the chemical characters of any given oil vary with its age, with the country where the raw material has been grown, and with the manner of its manufacture, as the author fully recognises. It seems probable that the reactions by which we distinguished one oil from another depend not so much on the oils themselves as on the presence of certain naturally accompanying impurities. In proportion as these are got rid of by refining, the distinctions upon which the analyst must rely fade away.

The rise of temperature produced by different oils on the addition of concentrated sulphuric acid has been proposed as a distinguishing test both by Maumené and Fehling. But the results of these two chemists are utterly irreconcilable. Thus, according to Fehling the four oils linseed, sesame, castor, and cod-liver, all show an increase of temperature of 74° (Fahr. or Cent.?), whilst Maumené gives the respective rise as 133°, 68°, 47°, and 103°. No one can use such a process until it has undergone a careful revision in competent hands. Chateau's process for the examination of fatty bodies as reported in the *Bulletin de la Société Industrielle de Mulhouse*, 1861, is quoted at some length, as is also the "oleography" of Prof. Tomlinson and Dr. Moffat (see Chemical News, vol. xviii., p. 299), which, to be satisfactory, requires great care and nicety of manipulation.

The method which the author recommends for determining the liability of any particular oil to gumming and drying is that of Nasmyth, and consists in observing how far a drop of the oil will travel in a groove cut in an inclined plane of iron or glass. We should strongly advise consumers of lubricating oils not to attempt their chemical examination in person, but commit it to a professional analyst.

The work before us is provided with a very copious index, but we regret to perceive a great number of typographical errors.

Structure and Development of the Brain. A Lecture delivered in the City Hall, Glasgow, under the auspices of the Glasgow Science Lectures Association. By Allen Thomson, M.D., F R.S. London and Glasgow: W. Collins, Sons, and Co.

We have here an account of the brain, clear, compact, and accurate; embodying the results of the latest investigations, and rendered perfectly intelligible to the non-professional mind. The learned lecturer deals successively with the origin, early formation, and development of the brain in the embryo, and the differences in its form, size, and structure among animals. He compares the human brain with that of the anthropomorphous apes, and touches on the varieties of form and size observed in the brains of different races and individuals. Lastly, he traces the relation and connection of the various portions of the brain, having due regard not merely to its more obvious structure, but to its microscopical texture.

Dr. Thomson fully admits that the differences of form and structure observable in the brains of the vertebrate animals may be regarded in some measure as a repetition of those presented by the embryo brains of the higher animals in the successive phases of their development, phyllogenesis and ontogenesis being thus parallel. But he points out that in the convoluted condition of the cerebral hemispheres there is no regularly increasing gradation. Nearly smooth and highly convoluted brains may be met with, even within one and the same mammalian order. Thus, among the Monotremes, the brain of *Ornithorynchus* is nearly smooth, whilst that of *Echidna* is strongly convoluted. Even in the Primates the plane hemispheres of the *Hapalidæ*, such as the Marmozet, contrast strikingly with the highly developed convolutions in man and in the anthropoid apes.

The relation of these convolutions to intelligence will appear at least questionable if we reflect that in the Rodents they are very small in size. Yet the intelligence of at least one rodent form, the common rat, is but too well known.

In comparing the brains of the European races with those of savages, the author seems to overlook the perplexing fact that the average Esquimaux brain is at least equal in size and weight to that of civilised nations. The weight of the brain in relation to that of the whole body fails likewise to throw any satisfactory light upon the gradation of intelligence. The brains of the smaller monkeys and of certain birds, such as finches, are proportionately double the weight of that of man.

When we add, in conclusion, that this treatise can be procured for the sum of three pence, the ignorance concerning the structure and functions of the brain, which is met with even among people of culture, must be considered simply inexcusable.

General Physiology of the Nervous System. A Lecture delivered in the City Hall, Glasgow, under the auspices of the Glasgow Science Lectures Association. By J. Gray M'Kendrick, M.D., &c. London and Glasgow: W. Collins, Sons, and Co.

This lecture may be considered as a continuation of that of Dr. Allen Thomson. The author reviews the entire nervous system not so much from a structural as from a functional point of view. The author explains the points of similarity, and also the distinctions between electrical conduction and nervous action, and shows that in man, and probably in other warm-blooded animals, the propagation of the latter is more than a thousand times slower than the speed of electricity along a copper wire. The nature of reflex movements is next explained—a subject on which much popular misapprehension prevails, and is eagerly utilised by humanitarians and sentimentalists of the day. The functions of different portions of the brain are next discussed, as far as our very rudimentary knowledge will allow. Lastly, the author turns to the connection between mental phenomena and the varying physical states of the brain. Admitting the existence and the intimate character of such connection, he very judiciously declares that we have no evidence for regarding the mental states as simply the product of such physical changes, or for assuming that when these physical operations cease the mental states cease also.

These "Science Lectures," if the attendance has been in any degree proportionate to their merit, must have been productive of great good, which will be further heightened by their re-appearance in the present cheap and convenient form.

CORRESPONDENCE.

PRESENCE OF ALCOHOL IN ANIMAL TISSUES DURING LIFE.

To the Editor of the Chemical News.

Sir,—Years ago the late Dr. Anstie and myself showed that animal tissues, when distilled with water, yield a distillate containing traces of a substance which gives all he characteristic reactions of alcohol. In our researches on the elimination of alcohol, we had not only recognised this, but made allowance for the presence of this natural alcohol. The discovery is, therefore, not a recent one, and is not due to T. Béchamp.—I am, &c.,

A. Dupré.

October 18, 1879.

METHOD FOR THE ESTIMATION OF THE OXIDE OF IRON AND ALUMINA IN COMMERCIAL PHOSPHATES.

To the Editor of the Chemical News.

Sir,—The following method of estimating the oxide of iron and alumina existing in phosphates, which I have found very expeditious, and more reliable than the ordinary process of precipitating with acetate of ammonium, may be found useful by some of your readers.

Determine the total P_2O_5 in the sample by precipitation with magnesia mixture. Dissolve a fresh portion of the sample in HCl plus a few drops of HNO_3, precipitate the lime as oxalate without troubling to separate the silica, filter, add a few crystals of potassium chlorate to the filtrate, boil well, add a slight excess of ammonia, boil, and filter off the precipitate of iron and alumina phosphates, dry, burn, and weigh it. In the filtrate estimate the P_2O_5 remaining in solution by standard uranium; the amount found subtracted from the total amount in the sample gives the P_2O_5 in the iron and alumina precipitate; subtracting this, therefore, from the weight of the precipitate, we get the oxide of iron and alumina present in the sample. The method does not take long and gives very accurate results.—I am, &c.,

T. Twynam.

Chemical Laboratory and Assay Offices,
106, Leadenhall St., London, E.C.,
October 20, 1879.

PYRITES-SMALLS IN THE MANUFACTURE OF SULPHURIC ACID.

To the Editor of the Chemical News.

Sir,—Since that matter is of considerable interest for British vitriol manufacturers, I beg permission to add a few words to the remarks made by Mr. Watson Smith in the Chemical News, vol. xl., p. 189, on the burning of pyrites-smalls. The amount of sulphur left in the burnt ore, where the "shelf-burner" is used, is not 5 per cent, but never above 1½, sometimes only ½, on the average perhaps 1 per cent. This I found to be the case both in France and in Germany, as well as at the Uetipon Works, near Zürich, referred to by Mr. Smith, whose description is perfectly correct in every other way. The raw material used here and in France is 48 per cent Chessy pyrites, in North Germany 44 per cent Schwelm pyrites. The burnt ore is taken straight from the vitriol works to blast-furnaces, being pure enough for this purpose. It is strange that this most efficient of all pyrites-burners is so little known or appreciated in England, although (or perhaps because) it is not protected by a patent. In my "Treatise on the Manufacture of Sulphuric Acid and Alkali," there are diagrams both of the original Malêtra burner and of the improved Aussig burner, of which my friend M. Schaffner has enabled me to give the fullest working drawings. The Aussig burners are immediately connected with a Glover tower, which proves that the difficulty caused by flue dust has been entirely overcome in their construction; and both the yield of vitriol and the consumption of nitre in that place are among the most favourable I ever heard of.—I am, &c.,

George Lunge.

The Polytechnicum, Zürich,
October 20, 1879.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 14, October 6, 1879.

Artificial Laurite and Ferriferous Platinum.—H. Sainte-Claire Deville and H. Debray.—The common metals, such as iron and lead, exist in nature in various combinations, but the most abundant which constitute their true ores are precisely those which we see formed under her eyes, when these same metals are abandoned to the action of atmospheric agencies. Laurite may be obtained by heating a mixture of ruthenium and iron pyrites. The sulphur resulting from the decomposition of the pyrites combines with the ruthenium, and this sulphide dissolves in the ferrous sulphide, and crystallises on cooling in regular octahedra, like natural laurite. All the sulphides of the platinum metals are decomposable by heat at a temperature sufficiently high. By heating laurite until the crucible began to soften, metallic ruthenium was obtained in small cubic crystals. A platinum sulphide was obtained by melting platinum with ten times its weight of pyrites, no compound similar to laurite being formed. If the above mixture is very strongly heated, the regulus, after treatment with hydrochloric and nitric acid and potassa, yields ferriferous platinum.

A Sporadosideric Meteorite, which fell January 30, 1879, at La Bécasse, Indre.—M. Daubrée.—The meteorite is 2·800 kilos. in weight; its paste or main mass consists of peridote and a bisilicate, like pyroxene or enstatite, interspersed with metallic grains of nickeliferous iron, accompanied by troilite.

Mathematical Theory of the Changes of Brightness of Variable Stars.—H. Gylden.—Not suitable for abstraction.

Synthesis of a Diphenyl-propane and on a New Method of Formation of Dibenzyl.—R. D. Silva.—On causing ordinary propylen chloride to act upon benzol in presence of aluminium chloride, the author obtained a liquid of an agreeable odour, and boiling without decomposition at the atmospheric pressure, which he supposed to be a diphenyl-propane. On endeavouring to produce allyl-benzol by causing chloride of allyl to act upon benzol in presence of aluminium chloride, he obtained diphenyl-propane.

Reaction of Cyanamide upon Hydrochlorate of Dimethyl-amin.—P. Tatarinoff.—Dimethyl-guanidin is formed by the action of heat upon cyanamide and dimethyl-amin hydrochlorate in molecular proportions. The composition of its platinum compound is—

$$(C_3H_9N_3,HCl)_2PtCl_4.$$

Mineral Associations Contained by Certain Trachytes of the Riveau Grand, Mont Dore.—F. Gonnard. —Not suitable for abstraction.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin No. 9, 1879.

Atomic Weight of Antimony.—F. Kessler.—The author criticises the researches of J. P. Cooke and considers that the atomic weight of antimony may still be taken at 122·3 (O = 16), or 122 (H = 1, O = 15·96).

Liquid Toluol-sulpho-chloride, and the Toluol-meta-sulphuric Acid of Beckurts.—C. Fahlberg.—The author considers it indubitable that the toluol-meta-sulph-amid of Beckurts consists of a mixture of toluol-para-sulph-amid and toluol-ortho-sulph-amid.

Benzal-sulphide and Sulpho-benzaldehyd.—C Böttinger.—Not suitable for abstraction.

Behaviour of the Acids of Nitrogen with Sulphuric Acid.—G. Lunge.—Hyponitric acid cannot under circumstances exist as such in contact with sulphuric acid, but is decomposed into nitrous acid, which immediately forms nitrosyl-sulphuric acid (chamber crystals) with a portion of the sulphuric acid, and nitric acid which dissolves as such. The nitrosyl-sulphuric acid dissolves in the excess of sulphuric acid, forming a colourless liquid, but only up to a certain limit, which may be regarded as the saturation-capacity of sulphuric acid for nitrosyl-sulphuric acid, and which rises with the concentration of the sulphuric acid. Above this limit there is produced a yellow colouration. As such acids become colourless on prolonged boiling, the excess of nitrosyl-sulphuric acid appears to be in an unstable state of combination; it does not, however, appear affected by the temperature of the water-bath. The circumstance observed by Winkler that a mixture of sulphuric acid at 66° B. and hyponitric acid displayed an orange colour, emitted red vapours, and that a violent disengagement of hyponitric acid took place on the application of heat, proving that this latter acid was present unchanged, can only occur if the mixture contains far more hyponitric acid than ever occurs in the manufacture of sulphuric acid. Every nitrose (*i.e.*, solution of nitrosyl-sulphuric acid in sulphuric acid), whether nitric acid is also present or not, takes, if heated far below its boiling-point, a golden or still darker yellow shade, but becomes colourless again on cooling. This change of colour can be repeated at pleasure; it points scarcely to a loosening of the compound, which displays great permanence even at a much higher temperature, but may rather be compared with the heightening of the colour of ferric chloride when heated. The stability of nitrosyl-sulphuric acid dissolved in sulphuric acid is great, even at the boiling-point of the latter if its sp. gr. is not below 1·70. Nitrogen is indeed continually lost during boiling, and the more the less concentrated is the acid. But if the boiling is so conducted that the escaping vapours cannot be condensed and flow back, nitrosyl-sulphuric acid is found in the residue, even at sp. gr. 1·65°. If the vapours are condensed and flow back, a considerable loss takes place by denitration. Down to 1·65 sp. gr. the affinity for nitrous acid, *i.e.*, the tendency to form nitrosyl-sulphuric acid, is so great that nitric acid simultaneously present, whether added as such or formed by the decomposition of hyponitric acid, is reduced with escape of oxygen, and is expended in the formation of nitrous sulphuric acid. With acid of sp. gr. 1·71 or still stronger, this conversion is almost complete after a short boiling; at 1·65 sp. gr. it is incomplete. This is a further argument against the presence of hyponitric acid in the solution. Below 1·65 sp. gr. nitrosyl-sulphuric acid is so unstable that most of it, if not all, is expelled from an acid of 1·6 sp. gr. by a short boiling. In an acid of sp. gr. 1·5 partial decomposition of the nitrous acid occurs, even in the cold, with formation of nitric acid and nitric oxide, but after heating for an hour in the water-bath considerable quantities of nitrosyl-sulphuric acid remain undecomposed, whilst another part passes into nitric acid. On boiling the former portion is totally lost. In consequence of the very low saturation-capacity of sulphuric acid at 1·5 sp. gr. for nitrosyl-sulphuric acid, free nitrous acid is present along with the latter in the cold. In still weaker acids this occurs in a higher degree; it is, however, probable that even very dilute sulphuric acid can contain, in the cold, a little nitrosyl-sulphuric acid if reducing agencies are absent. The nitric acid co-existing with nitrosyl-sulphuric acid remains in great part in the liquid after long boiling, and even in acids of sp. gr. 1·5 and lower. If, therefore, the nitrose from the Gay-Lussac tower of a vitriol works in consequence of bad management contains nitric as well as nitrous acid, it cannot be completely denitrised by hot water or steam, not going below 48° B. = 1·5 sp. gr. The end can only be effected by reducing agents, as on the large scale by sulphurous acid in the Glover tower, and on the small scale by mercury in the nitrometer. It can be plainly seen in the latter how much more difficult and tedious the process of denitrification becomes if nitric acid is present. The tendency to the formation of nitrosyl-sulphuric acid is so strong that even when there is a very large simultaneous introduction of air and consequently of oxygen into the sulphurous acid, along with nitrous acid or nitric oxide, no oxidation to N_2O_4 or NO_3H can be traced. Nitrous acid cannot be absorbed by soda-lye without loss, as it is partially resolved into nitric acid and nitric oxide. The violet colouration which appears during the action of reducing agents upon a nitrose is due to the solution of nitric oxide in the acid, and is possibly the result of a very unstable compound of nitrogen and oxygen, between NO and N_2O_3.

Organic Thio Compounds.—O. Wallach and H. Bleibtreu.—The authors have obtained a series of homologues of a compound which they recently prepared by the action of iodethyl upon the sodium compound of thiacetanilid.

Thiamids of the Oxalic Acid Series.—O. Wallach and P. Pirath.—Not suitable for abstraction.

Certain New Salts of Aniline.—Miles Beamer and F. W. Clarke.—A description of the chlorate, perchlorate, iodate, hydrofluorate, phthalate, and mono-, di-, and trichloracetate.

Remarks on Lithium Picrate.—M. Beamer and F. W. Clarke.—The authors obtain this salt by dissolving lithium carbonate in an alcoholic solution of picric acid.

Bilic Acid, a New Oxidation-product of Cholic Acid.—F. Egger.—The author obtains this substance by acting upon 30 grms. cholic acid with 60 grms. potassium bichromate with 32·5 c.c. concentrated sulphuric acid diluted with 8 vols. of water. Action is set up on the application of heat. The composition of the pure acid is $C_{16}H_{22}O_6$.

Derivatives of Oxy-propyl-benzoic Acid.—R. Meyer. —The principal of these derivatives is para-acetyl-benzoic acid.

H. Kœhler's Observations on Mercuric Iodide.—K. Kraut.—The writer is not willing to accept Kœhler's results on the melting-point of mercuric iodide.

Synthesis of Chrysen.—C. Graebe and H. Bungener. —The authors obtain chrysen by the same method which led to the transformation of stilben and dibenzyl into phenanthren.

New Synthesis of Desoxybenzoin.—C. Graebe and H. Bungener.—Chloride of phenyl-acetic acid was treated with an excess of benzol and with aluminium chloride.

Derivatives of Mucic Acid.—E. Seelig.—An extensive memoir on dehydro-mucic acid and its salts.

Sulphuretted Acids formed by the Introduction of Brom-benzol and Chlor-benzol into the Organism. —M. Jaffé.—Not suitable for abstraction.

Constitution of Indigo.—E. Baumann and F. Tiemann. —An essay on the constitution of sulphindoxylic acid, on the conversion of indoxyl into indigo, and on the constitution of the latter.

Oxidation-products of Quinin.—Z. H. Skraup.— Among these are quitenin, $C_{19}H_{22}N_2O_4+4H_2O$, formic acid, and quinic acid, $C_{11}H_9NO_3$.

Constitution of the Quinin Bases.—Z. H. Skraup. —A theoretical memoir, not susceptible of useful abstraction.

Synthesis of Iso-succinic Acid.—H. Züblin.— Malonic ether in contact with sodium gives off hydrogen in abundance, and when treated according to the usual method for preparing sodium-acetic ether, it gives a product which was converted into iso-succinic ether by the action of iodmethyl.

Determination of the Vapour-densities of Certain Inorganic Bodies at Elevated Temperatures.—V. Meyer and C. Meyer.

Lecture Experiments.—A. W. Hofmann.—This paper also requires the accompanying illustrations.

Action of Phosphor-penta-chloride upon the Oils of Mustard and Cognate Bodies.—A. W. Hofmann.—An account of the choro-phenyl-oxyphenyl and amido oils of mustard.

Action of Hydrochloric Acid (Dry) upon Terpens.—W. A. Tilden.—Terpens of the two classes boiling respectively at 156° and 176°, and which are widely different in their optical behaviour, can be thus converted into one and the same inactive hydrocarbon.

No. 10, 1879.

Formation of Cinchomeronic Acid from Quinin, and its Identity with Pyridin-dicarbonic Acid.—H. Weidel and M. v. Schmidt.—The authors have obtained and examined the acid and neutral soda salts and the neutral lime salt of this acid. Among the products of the oxidation of cinchonin with nitric acid formed simultaneously are cinchonic (carbo-quinolinic acid), quinolic acid, cinchomeronic and oxy-cinchomeronic acids.

Nitro-phenanthren and its Derivatives.—G. A. Schmidt.—The author took for his point of departure mono-nitro-phenanthren, and finds that this compound exists in three isomeric forms. Among the derivatives obtained are amido-phenanthren, α-mono-nitro-phenanthren-quinon, β-mono-nitro-phenanthren, and γ-mono-nitro-phenanthren.

Reply to a Reclamation of Priority concerning the Reaction of Metallic Chlorides upon Aromatic Hydrocarbons.—B. Aronheim.—A. reply to Mr. Watson Smith.

A Correction.—J. Nessler.—A reply to Dr. Lunge's note on gypsiferous wines.

Poly-substituted Ureas.—W. Michler and C. Escherich.—This memoir (a continuation) appears as two distinct papers in which the authors describe the reactions of chlorocarbonic oxide and dimethyl-amin, of dimethyl-urea-chloride with dimethyl-amin, of chloro-carbonic oxide and mono-methyl-amin, and of ammonia upon methyl-phenyl-urea-chloride.

Notice on the Nitrising of Benzol-sulphanilid.—W. Michler and G. Blattner.—A preliminary notice of experiments, undertaken in order to obtain highly nitrised nitro compounds by treating sulphanilides with fuming nitric acid.

Behaviour of Amines with Sulpho-chlorides.—W. Michler and G. Moro.—In this, the first section of their treatise, the authors describe the reaction of trichlormethyl-sulpho-chloride and dimethyl-aniline. The resulting compound has a formula suitable for a tetra-methyl-diamido-benzo-phenon.

Phosphates of Zinc.—W. Demel.—The author has examined the acid zinc salts of phosphoric acid, and gives an elaborate crystallographical account of—

$$ZnO,P_2O_5.2H_2O+2H_2O.$$

Analysis of a Turkey-red Oil.—G. Stein.—The author's method is to weigh 10 grms. of the sample into a porcelain capsule holding about 125 c.c., adding 75 c.c. cold saturated solution of common salt, and 25 grms. of dry wax. The whole is then heated on a water-bath. As turkey-red oil is insoluble in brine it rises in an anhydrous condition to the surface and combines with the melted wax. The cake of wax, when cold, is freed from brine by means of filter-paper, dried over sulphuric acid and weighed. On deducting the known weight of the wax the residue is the real oil.

Constitution of Sulpho-toluid.—R. Otto.—The author describes di-para-toluol-sulphide and di-para-toluol-sulphon.

Formulæ of Quercitrin and Quercetin.—C. Liebermann and S. Hamburger.—The authors assign to quercitrin the formula $C_{36}H_{38}O_{20}$, which agrees well with that of Hlasiwetz and of Rigaud. To quercetin they give $C_{24}H_{16}O_{11}$, the analysis likewise agreeing closely with those of Rigaud, Hlasiwetz, and Zwenger and Droncke. They have also formed and examined a number of the derivatives of quercetin.

Mercuric Chloro-iodide.—H. Kœhler.—The author has established the real existence of this compound, $HgClI$, as a chemical individual.

Constitution of Indigo.—E. Baumann and F. Tiemann.—The authors consider it necessary to ascertain whether indigo is a derivative of diphenyl or of distyrenyl, and whether it contains imid groups.

Determination of the Vapour-density of Certain Chlorides.—V. and C. Meyer.—The vapour-densities here ascertained are those of stannous chloride, zinc chloride, and ferric chloride. Concerning the first of these compounds they consider it established that it should be represented not by the more simple formula, but by that corresponding to the molecular magnitude Sn_2Cl_4.

Conversion of Furfurangelicic Acid into Azelainic Acid.—P. Tonnies.—The ultimate step in this transformation is the reduction of butyro-furonic acid to azelainic acid.

Relations of Dibrom-pyro-mucic Acid to Mucobromic Acid.—P. Tœnnies.—A hypothetical paper.

Bulletin de la Société Chimique de Paris, No. 3, 1879.

New Method of Determining Sulphur in certain Native Sulphides.—Albert Colson.—The author proposes to burn pyrites in a current of oxygen, and to titrate the products of combustion. The operation is carried on in a tube of green glass, placed in a furnace for organic analysis. One end of the tube is sealed, and to the other is fitted a stopper with two holes. One of these serves for the escape of the gaseous products of combustion which are received in a Liebig's bulb apparatus containing standard caustic soda. Through the other hole passes a long narrow tube, which conveys oxygen, free from water and carbonic acid, to a small platinum boat placed near the closed end of the combustion-tube, and containing half a gramme of the pyrites spread out in a thin layer. A plug of asbestos is placed about the middle of the tube, to avoid projections. Heat is first applied towards the open end of the tube, and as it approaches redness it is gradually extended towards the closed end. The current of oxygen is regulated so as to be always in excess. The disappearance of the white vapours formed in the bulb-tube during the operation is a sign that the sulphurous acid is expelled from the combustion-tube. The open end of the tube and the stopper are then washed, and the washings are added to the liquid in the bulb-tube, the sulphurous acid in which is then determined in the usual manner. If the pyrites contain carbonates, standard solutions cannot be used. It is then necessary to oxidise the sulphurous acid and determine the sulphuric acid formed.

Thermic Formation of Hydrogen Silicide.—J. Ogier—The union of $Si+H_4$ is accompanied with a disengagement of heat to the extent of $+24{\cdot}8$ cal.

Thermic Formation of Silicic Ether.—J. Ogier.—The heat of formation of silicic ether from pure alcohol and silica dissolved in water is 11·44 cal.

A New Derivative of the Parabanic Series.—E. Grimaux.—The substance in question is the amide of an oxalyl-biuretic acid, comparable to oxaluric acid.

Neutral Sugar and Inverted Sugar.—P. Horsin Déon.—Neutral sugar and inverted sugar have the same composition, equal parts of glucose and levulose. Neutral sugar is an inverted sugar in which the glucose possesses its maximum rotatory power. Its formation is the first step towards the inversion of sugar.

Palm-Sugar from Calcutta.—P. Horsin Déon.—This sugar is composed chiefly of cane-sugar, along with reducing sugar, gum, and mannite.

Researches on the Bacillus Ferment of Urea.—P. Miquel.—*Bacillus ureæ* belongs to the class of beings which M. Pasteur names *Anærobia*. At the end of its life it is resolved into brilliant, slightly elliptical, spores, which can resist for several hours a moist heat of 95° to 96°.

Hydrosulphuric Fermentation.—P. Miquel. — The author considers that there exists at least one organism capable of hydrogenising sulphur to an appreciable extent. This *Microbium*, which is met with in abundance in sewage, in drinking-waters, and even sometimes in rain-water, attacks insoluble albumen, and eliminates the bulk of its sulphur in the state of free hydrogen sulphide.

La Correspondance Scientifique.
No 63, October 7, 1879.

This issue contains neither chemical nor physiological matter.

MISCELLANEOUS.

City and Guilds Institute.—The City and Guilds of London Institute for the Advancement of Technical Education, announce the opening of their Technical Classes, at Cowper Street School, Finsbury. In the Section of Applied Physics, Mr. W. E. Ayrton will deliver a course of twelve lectures on "Some of the Practical Applications of Electricity and Magnetism," commencing Monday, November 3rd, at 7 p.m. In that of Applied Chemistry, Dr. H. Armstrong, F.R.S., will deliver a similar course on "The First Principles of Chemistry," commencing Wednesday, November 5th, at 8 p.m. An Inaugural Lecture will be delivered by Mr. Ayrton, on Saturday, November 1, at 8 p.m., on "The Improvement Science can Effect in our Trades, and in the Condition of our Workmen." A syllabus of each Course of Lectures can be obtained at the Halls of the Companies of Mercers, Clothworkers, and Drapers, or at the Schools, Cowper Street, Finsbury. Intending students should send in their names to the Demonstrator, Cowper Street Schools, Finsbury, E.C. The Inaugural Lecture will be free.

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THE CHEMICAL NEWS.

Vol. XL. No. 1040.

SEPARATION AND DETERMINATION OF MANGANESE.

By Professor J. VOLHARD.

The following account of this process is condensed from *Liebig's Annalen.* The author makes use of a standard solution of potassium permanganate, which he prepares by dissolving 38·5 grms. crystals of permanganate in about 2 litres water in a boiling-flask. The solution is poured into a well-stoppered bottle which holds 10 litres, filled up to the mark with water and well mixed by shaking. This store is kept in a dark place. To fill the burettes, the author uses a 1-litre washing bottle with a wide mouth covered with black paper. Before filling this vessel out of the stock-bottle, it is several times washed out with a little of the solution. The value of the permanganate solution is then determined, which is best effected iodometrically. For this purpose there are required a solution of sodium hyposulphite and a starch solution, both of known strength, besides a solution of potassium iodide and one of starch.

The reducing liquid is obtained by dissolving 30·061 grms. pure crystalline sodium hyposulphite along with about 3 grms. ammonium carbonate and making up to 1000 c.c.; 1 c.c. of this solution = 2 m.grms. manganese. To prepare the iodine solution, 1·5394 grms. dry iodine in crystals are dissolved in a little water by the aid of 3·5 potassium iodide and made up to 1000 c.c., 10 c.c. of this solution are reduced by 1 c.c. of the hyposulphite solution. The potassium iodide solution should contain per litre 55 grms. potassium iodide free from iodate. The solution of starch is prepared fresh daily.

About 10 c.c. of potassium solution are placed in a beaker, 4 to 5 c.c. pure hydrochloric acid with 150 to 200 c.c. water are added, and constantly stirring about 20 c.c. of the permanganate solution are added from a Gay-Lussac burette. The beaker is then placed under the Mohr's burette containing the hyposulphite solution, and some of this is added till the brown colour of the iodide solution is changed to a faint yellow. Starch solution is now added, and hyposulphite again till the blue colour is completely destroyed. In order to determine the small excess of hyposulphite which has been added, solution of iodine is added with a small graduated pipette till the blue colour just reappears. The volume of hyposulphite consumed, less one-tenth of the iodine solution used and divided by the volume of the permanganate solution gives the factor of the permangate: 1 c.c. permanganate indicates 2 m.grms. × factor for manganese.

The standard of the hyposulphite solution should be checked from time to time. For this purpose the author uses a liquid prepared by dissolving 5·963 grms. potassium dichromate, and making up to 1000 c.c. Of this solution 1 c.c. gives up to hydriodic acid exactly as much oxygen as the quantity of permanganate, which indicates 2 m.grms. manganese; 20 c.c. of the chromate solution are measured off with a pipette, and let flow into the acidified solution of potassium iodide, proceeding exactly as directed above for standardising the permanganate. If more than 20 c.c. of the hyposulphite are used for reducing the iodine set free the hyposulphite was impure.

Any other permanganate solution of known strength will serve as well for the titration of manganese, and if a solution is kept in stock for the titration of iron, it would superfluous to prepare another. It must be remembered, however, that only three-fifths of the oxygen in the permanganate indicated by ferrous oxide, oxalic acid, or hydriodic acid comes into play in the oxidation of manganous oxide. The manganese standard may be found by multiplying the iron standard by 0·2946.

For the titration of manganese, if iron is absent, or present only in a small quantity, the solution of the salt of manganese is rinsed into a long-necked boiling-flask, with the addition of 1 grm. zinc sulphate, and diluted so that 100 c.c. may contain not more than about ¼ grm. manganese. If the solution is neutral, 2 or 3 drops of pure nitric acid are added (specific gravity 1·2); if acid, it is first neutralised with absolutely pure sodium carbonate, till a permanent precipitate begins to appear, then acidified with 3 or 4 drops of nitric acid and heated to a boil. The flask is taken from the fire and the permanganate run in with the burette, promoting the collection of the precipitate by vigorous shaking. The redness which appears towards the end, repeatedly disappears again on further agitation. If fine reddish-brown flocculi remain suspended in the liquid, so that it does not become thoroughly clear and transparent, the flask is set for a few minutes on a very gentle fire, but not allowed to boil.

The flocks become more compact and subside on shaking. The liquid at the end of the operation must have a distinct rose colour,* which must remain after repeated shaking. The zinc sulphate must be carefully tested; its dilute solution should not, on boiling, destroy the colour of a drop of permanganate.

Metallic alloys, such as cast iron and steel are dissolved for the determination of the manganese in dilute sulphuric acid with the addition of nitric acid. The solution is effected in a litre flask, heated on the water-bath. In a mixture of 3 volumes dilute sulphuric acid (1·13 specific gravity) and 1 volume nitric acid (1·4 specific gravity) common bottle-wire, on heating in the water-bath, dissolves in five or six minutes without violent evolution of gas. The digestion must be prolonged in order to convert the iron completely into oxide. Many ores and slags can only be dissolved by the aid of hydrochloric acid, in which case, after the oxidation of the iron, the hydrochloric solution is mixed with concentrated sulphuric acid and evaporated in a porcelain capsule, first in the water-bath and then in the gas-stove, till the sulphuric acid begins to escape. The mass is then rinsed with water into the litre flask. The more highly carburetted cast-iron, spiegeleisen, and ferromanganese are dissolved in nitric acid in a small flask; the solution, without filtration, is rinsed into a porcelain capsule, evaporated to dryness in the water-bath, and heated in the gas-stove to the complete decomposition of the nitrates, whereby the carbonaceous matters are burnt. The residual oxides are digested with hydrochloric acid in a covered capsule on the water-bath, when the oxides dissolve. The hydrochloric acid is then again expelled by heating with sulphuric acid.

The bulk of the acid is next neutralised with pure sodium carbonate or hydroxide. Zinc white suspended in water is then added till all the iron is thrown down, which is ascertained by the circumstance that the solution suddenly coagulates and the supernatant fluid becomes milky. The flask is then filled up to the mark with water, allowed to settle for some minutes, and filtered through a dry folded filter into a dry vessel. A part of the filtrate (200 c.c.) is placed in a boiling-flask, acidified with 2 to 4 drops nitric acid and heated to a boil. The flask is then taken from the fire, and the permanganate run in with the burette. The titration can be repeated with a second and a third portion of the liquid.—*Liebig's Annalen der Chemie.*

Technical Education.—A class in connection with the City and Guilds of London Institute for the Advancement of Technical Education, for the study of blowpipe analysis and assaying, will be commenced on Wednesday next at the Birkbeck Institution, by Mr. G. Chaloner, F.C.S.

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* The Germans understand, under "rosa," a colour rather inclining to the violet side of red.

ON THE CHEMICAL COMPOSITION OF AMBLYGONITE.[*]

By SAMUEL L. PENFIELD.

THE new mineral species triploidite described by Messrs. Brush and Dana[†] is shown by them to be isomorphous with wagnerite and closely related in composition to triplite. These three minerals have respectively the formulæ $(Mn,Fe)_3P_2O_8+(Mn,Fe)(OH)_2$, $Mg_3P_2O_8+MgF_2$, and $(Fe,Mn)_3P_2O_8+(Fe,Mn)F_2$. From a comparison of these formulæ it is argued (*l. c.*, p. 45) that the relation between the minerals requires the assumption that the hydroxyl in triploidite must play the same part as the fluorine in the other two.

In this paper the author wishes to show that in amblygonite the hydroxyl group is also isomorphous with fluorine, and that in chemical composition the original amblygonite does not differ from the American and Montebras varieties, which have been called hebronite. The results of his analyses require the adoption of a new formula for the mineral more simple than that previously accepted. For analysis he selected specimens from the three localities in Maine, from Branchville, Connecticut, where the mineral has been lately discovered by Messrs. Brush and Dana, also two varieties from Montebras and one from Penig, Saxony, from a specimen in the Yale College collection.

The ratios from the analyses are collected in the following table by themselves, where $\overset{\text{I}}{R}$ equals Li and Na :—

	P	Al	$\overset{\text{I}}{R}$	(OH,F)
I. Penig, Saxony	1·00	0·96	0·98	1·16
II. Montebras, France, A	1·00	0·97	0·98	1·17
III. Auburn, Maine	1·00	0·96	0·97	1·06
IV. Hebron, Maine, A ..	1·00	0·97	0·95	1·13
V. Paris, Maine	1·00	0·96	0·97	1·17
VI. Hebron, Maine, B ..	1·00	0·98	0·95	1·27
VII. Branchville, Conn. ..	1·00	0·97	0·96	1·09
VIII. Montebras, France, B	1·00	0·96	0·96	1·21

It will be seen that all of these approach closely to the ratio 1 : 1 : 1 : 1, hence the author proposes the formula $Al_2P_2O_8+2R(OH,F)$ or—

$$\left.\begin{matrix}3Al_2P_2O_8\\2R_3PO_4\end{matrix}\right\}+\left\{\begin{matrix}Al_2(OH,F)_6\\2R(OH,F)\end{matrix}\right.$$

as the true formula for all varieties of this mineral.

Des Cloizeaux, from a difference in optical characters made out by him, has divided the mineral into two species: the original amblygonite, including I. and II. in the above list; and a second species for which he proposed the name *montebrasite* (hebronite of von Kobell), including analyses III. to VIII. The mineral from Branchville has not been examined optically and the material is very unfavourable for such an examination. Owing to the close identity in chemical composition, it seems that a slight variation in optical properties is hardly sufficient ground for dividing the mineral into two species; but, on the contrary, the author thinks that the old name amblygonite should be retained, and that all varieties should be included by it.

It will be seen, in comparing the above ratios, that in every case the ratio of P to (OH,F) is in excess of that of the Al to R. Two theories suggest themselves to account for this, the first of which seems the most plausible. First, most minerals which are ordinarily regarded as anhydrous contain a small amount of water, which is not calculated in the ratios, and which is not regarded as essential to the composition. Now, if these minerals contain a small quantity of such accidental water, it will bring up the ratios very considerably, owing to the small molecular weight of water, and if the slight variation between P, Al, and R be regarded as due to error of analysis, the excess of (OH,F) would be easily accounted for. Second, if we regard the difference between P, Al, and R as not due to error of analysis, and the fact that the variation in all is so constant suggests this, and regard enough of the water basic so that when added to the Al and R it will make the ratio with P equal 1 : 1 : 1, then the ratio of (OH,F) will be :—Penig, 1·02; Montebras, A, 1·06; Auburn, 0·91; Hebron, A, 0·99; Paris, 1·02; Hebron, B, 1·18; Branchville, 0·97; Montebras, B, 1·05. This relation seems rather striking, and although it is not as simple as we should like to have it, or perhaps as plausible as the first theory, yet it may possibly be the correct one. Whichever of these explanations is accepted, it will not materially alter the formula above made out for the minerals, the variation from which is too slight and not constant enough to be expressed by any different formula. The analyses show that water is found in the Penig and Montebras varieties which have been regarded as anhydrous by some analysts. This may have been overlooked, and it is worth noting that in Plattner's "Blowpipe Analysis" the statement is made, of the Penig mineral, that water is expelled by heating in a closed tube. It will also be seen that these analyses differ from the older ones in that they are lower in alumina and higher in alkalies.

Method of Analysis.

Water was determined by ignition with oxide of lead in a porcelain crucible; it is completely driven off only by strong ignition, and it was found necessary to fuse the contents of the crucible over the blast lamp before constant results could be obtained. Fluorine was determined by decomposing a mixture of the mineral and powdered quartz with sulphuric acid, converting the silicon fluoride formed into hydrofluosilicic acid, precipitating the hydrofluosilicic acid with potassium chloride, and titrating the liberated hydrochloric acid with a standard alkali solution.[*] The varieties from Penig and Montebras are decomposed only by prolonged action of sulphuric acid Phosphoric acid was determined by fusing the mineral with sodium carbonate, boiling out the fused mass with water and dilute nitric acid, nearly neutralising the excess of acid with ammonia, precipitating with molybdic solution, and then proceeding in the usual way.

To determine the bases, one gramme was weighed into a large platinum crucible, mixed into a paste with from two to three c.c. of sulphuric acid, and heated, with the crucible covered, over a low gas flame till not over a c.c. of sulphuric acid remained. The contents of the crucible were then rinsed into a platinum evaporating dish, and treated with a quantity of strong hydrochloric acid; after heating and concentrating a clear solution was obtained. The excess of acid being removed by evaporation, the contents of the dish were rinsed into a beaker, filtered where necessary, the undissolved portion after incinerating the filter paper was treated with hydrofluoric acid, then with a drop of sulphuric acid; the hydrofluoric acid expelled by evaporation and the solution added to the other solution of the bases. To obtain the bases as chlorides the sulphuric acid was precipitated from the solution with barium chloride, and the barium sulphate filtered off. The solution was then heated to boiling, and a hot solution of barium hydroxide added; this precipitated all the phosphoric acid and part of the alumina. The solution contained all the lithia and most of the alumina which went into solution in the excess of barium hydroxide. After filtering and washing the precipitate it was dissolved in hydrochloric acid, the excess expelled by evaporation; the residue taken up in a few drops of hydrochloric acid and water, and poured when hot into a boiling solution of sodium hydroxide and a little barium hydroxide in a platinum dish; this again precipitated all the phosphoric acid, while the alumina went into solution in the alkaline hydroxides. After filtering, the filtrate was acidified with

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[*] Abstract of a paper in the *American Journal of Science.*

[†] *Am. Jour. Sci.*, III., xvi., 42, July, 1878.

[*] See Remsen's *Am. Chem. Jour.*, vol. i, No. 1.

hydrochloric acid, the barium precipitated with sulphuric acid, and the alumina precipitated with ammonia. The alumina found at this point amounted usually to about one-half per cent. The insoluble barium phosphate containing also traces of iron, manganese, and calcium was dissolved in hydrochloric acid, the barium precipitated with sulphuric acid, filtered, and the filtrate made alkaline with ammonia; this precipitated any iron, manganese, or calcium as phosphate, which was filtered off and examined separately. It was intended at this point to determine the phosphoric acid by direct precipitation with magnesia mixture, but the results coming out too low an examination of all the barium sulphate precipitates showed that a quantity of the phosphoric acid had been precipitated along with the barium sulphate. The first filtrate from the barium hydroxide precipitate contained, free from phosphoric acid, all the lithia, the larger part of the alumina, and the excess of barium. It was heated to boiling and ammonium carbonate added; this precipitated the barium and aluminium, and left the lithia in solution. The precipitate was washed first by decantation, then with hot water on the filter pump; it was not considered free from lithia, however, as it is practically impossible to wash a large barium carbonate precipitate free from lithia. The filtrate was evaporated to dryness, the ammonia salts expelled by ignition, traces of barium separated a second or third time when necessary, evaporated to dryness again, lithia separated from soda and potash by means of absolute alcohol and ether, the lithia weighed as sulphate, and the soda and potash as chlorides. The chlorides were tested carefully for potash by evaporating with excess of platinum chloride and taking up in alcohol. The precipitate produced by ammonium carbonate was dissolved in hydrochloric acid, the barium precipitated with sulphuric acid, filtered, and alumina precipitated in the filtrate with ammonia, the precipitate was washed with hot water, ignited finally over the blast lamp to expel sulphuric acid, and weighed as oxide. The filtrate from the alumina was regarded as containing a trace of lithia which had been retained by the barium carbonate precipitate, it was evaporated to dryness, the ammonia salts expelled by ignition, taken up in water, filtered into a weighed crucible, evaporated to dryness and weighed, the lithia found amounted to from one-quarter to one per cent.

The solutions were kept as far as possible from all contact with glass, the evaporations being carried on in large platinum dishes. The reagents were carefully selected and purified. Sodium hydroxide free from aluminium and silica was obtained, prepared from metallic sodium. Owing to the limited amount of material from Penig only three-quarters of a gramme was used in the determinations, and duplicates of the water and fluorine determination were not obtained. For the occurrence and associations of amblygonite at Branchville, Connecticut, see the papers by Messrs. Brush and Dana.*

Sheffield Laboratory, June 18, 1879.

ANALYSIS OF CINCHONA BARKS.

A CORRESPONDENT favours us with the following valuable information on this subject, in answer to a question which appeared lately in our "Notes and Queries" column.

"ETHER PROCESS,"

FOR THE ESTIMATION OF QUININE IN CINCHONA BARK.

Take 1000 grains finely-powdered bark; 8 fluid ozs. of alcohol (methylated) at 35 to 40 per cent, sp. gr. 0·872; 500 grains hydrate of lime; 16 fluid ozs. ether (methylated), 0·730 sp. gr.

Let the bark be powdered without leaving a residue, and passed through a sieve of at least 100 meshes to the inch (fine cypress). Pour upon the powder sufficient alcohol to form a liquid paste, heat for a few minutes until the fibre is thoroughly penetrated by the liquid. Introduce into the paste the hydrate of lime in fine powder, mix thoroughly, heat on a plate until all the alcohol is expelled and the powder thoroughly dry. Treat this in a displacement-apparatus with successive portions of ether; thus 4 ozs. to macerate, and *six* successive 2 ozs.; evaporate percolate rapidly.

1. Fuse product at 120° C. = crude quina + colouring- and fatty-matter.
2. Dissolve the residue in alcohol, and estimate with standard sulphuric acid = total sulphate of crystalline and amorphous quina.
3. Weigh the sulphate of quinine crystals obtained.

Cinchona barks of all species contain a natural acid, called by some kinic and by others quinovic acid. This acid exists in combination with one or more of the alkaloids, quinia, quinidia, cinchonia, cinchonidine, according to the variety of the bark.

Calisaya Bark (Bolivia), of both quilted and flat varieties, contains wholly, or almost wholly, quinia; quinidia and cinchonia being rarely met with. (Ether process specially adapted.)

Red Bark, Carthagena, Soft Columbian, by which names they are known in commerce, contain both alkaloids of quinia and cinchonia, and to a greater or less degree quinidia. The ether process is also applicable, in so far as the estimation of the quinia and consequent determination of the commercial value for the manufacture of quinine is concerned.

Loxa, Brown, or Grey Barks, commercial names, contain almost wholly cinchonia and cinchonidine. The ether analytical process is *not* applicable to this variety.

The lime is added to decompose these quinovates of the alkaloids, in order that the latter may be exposed to the solvent action of the menstruum in the free state.

The etherial solution (percolate) will contain the total quinia *with traces only* of the other alkaloids when they are present, together with fatty- and colouring-matter.

Evaporated etherial solution, fused at 125° C., will be the total *crude* quinia plus colouring- and fatty-matter. *Note the weight.*

Dissolve by aid of a water-bath in about 1 oz. of absolute alcohol, and add gradually (having a piece of litmus paper in the solution), until a *faint* acid reaction is indicated, a standard sulphuric acid of known strength, by preference one in which 100 c.c. = 10 grms. crystal sulphate quinine, if a 1000 grain measure burette be used, so that 1000 = 100 grains quinia sulphate crystals. *Note quantity of acid for neutralisation.*

Product estimated as total basic sulphates of crystalline and amorphous quinia. The strength of the acid can easily be deduced from the following:—

Composition of air-dried crystal sulphate of quinia—

$$\begin{array}{rrl} & 74{\cdot}31 & \text{anhydrous quinia.}\\ (SO_3-) & \left.\begin{array}{r}9{\cdot}17\\ 2{\cdot}06\end{array}\right\} & 11{\cdot}23\text{ mono-hydrated acid.}\\ & 14{\cdot}45 & \text{water lost at }100^\circ\text{ C.}\\ \hline & 100{\cdot}00 & \end{array}$$

If pure sulphuric acid of 1·843 sp. gr. = 96·8 per cent of H_2SO_4 real, then 11·23 = 11·6 acid of sp. gr. 1·843.

Take, therefore, 11·6 grms. and dilute to a litre with water

To this alcoholic basic sulphate, when evaporated to dryness, add as many measures of the standard acid as used in the first instance. This will convert basic sulphate of quinine into acid sulphate, a salt exceedingly soluble (unlike ordinary sulphate, which will crystallise in the filter). Add about 1 oz. of water, and boil with a spirit-lamp, being careful that no portion on the sides of the dish (No. I.) become charred.

Solution of the salt being complete add a small quantity of *animal charcoal* (about 5 per cent of the bark originally

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* *Am. Jour. Sci.*, July and August, 1878, and May, 1879.

used). This animal charcoal should be completely purified by previous digestion in hydrochloric acid until the phosphate of lime is nearly wholly removed. Digest for about ten minutes, or longer if time is no object, then filter into a small dish (No. II.), wash the filter with two successive portions of boiling water (boiled in dish No. I.) acidulated with about a drachm (to cleanse it of all alkaloid) of the standard sulphuric acid.

The filtrate will consist of a decolourised solution of acid sulphate of quinine, strongly acid to litmus, and on the filter will be left with the animal charcoal all colouring- and fatty- (tarry ?) matter.

Now evaporate the liquors (on a water-bath if time will permit) to about 1 fluid oz., or more if the bark is very rich in alkaloid (such as in quilted Calisaya barks for instance); raise to boiling-point, and add *very cautiously*, drop by drop, solution of ammonia of about 3 per cent (1 part liq. ammon. 0·880, 10 parts water), until the solution has but a faint acid reaction, at which stage the quinia salt will again be as a basic sulphate; set aside to cool. When cold the whole will be a mass of crystals. Throw upon a dry filter, and allow the mother-liquor to drain away. This liquor will contain the sulphate of amorphous quinia, any traces of the sulphates that may have been present, of cinchonia, cinchonidine, and quinidia, with sulphate of ammonia.

If the experiment has been properly conducted no crystalline sulphate of quinine will be in this mother-liquor, as *sulphate of ammonia* decreases the solubility of sulphate of quinine.

Until, however, the operator becomes perfectly familiar with the process it would be advisable to evaporate this mother-liquor, neutralise any excessive acidity, and look for a further crop of crystals, which will rarely exceed 0·1 per cent of the bark operated on.

Dry crystals in air; weight = amount of crystalline sulphate of quinine in original bark. A more rapid and certain method is to dry them at 100° C., and estimate as 85·5 dry = 100 crystals (vide composition of sulphate of quinine).

Any method of analysis intended as a sure guide for the manufacture of quinine must embrace a stage in which the quina is weighed as *pure white sulphate.*

Advantages of this Process as Compared with Acid Process.

1. Rapidity (twenty-four hours at the most.)
2. Extraction of that alkaloid only upon which the commercial value of the cinchona barks depend.
3. Non-production of amorphous quinia, so liable by protracted boiling, as in acid process.
4. Inexpensive.

"ACID PROCESS,"

For the Complete Analysis of any Variety of Cinchona Bark.

Take of bark in fine powder 1000 grains; sulphuric acid (1·843), 50 grains; water, 2 pints; hydrate of lime, a sufficiency.

Add the acid to the water, and divide it into two portions, in which successively boil the bark. After each decoction throw upon a calico filter until drained; then boil the bark in ½ pint of water only, drain upon filter, and press. Mix the decoctions, concentrate to ½ pint, cool, and add milk of lime until the liquid is distinctly alkaline. Collect the precipitate by filtration, and purify by careful washing, then dry at 95° to 100° C., and powder. Boil this powder repeatedly in strong alcohol (about 90 per cent), and evaporate alcoholic extracts to dryness. Boil the residue with acidulated water, and filter. Make the solution alkaline with caustic soda (this alkali is to be preferred, as quinia is insoluble in soda but soluble slightly in potash or ammonia) in a separator, and shake with chloroform. Draw off chloroform solution, and evaporate in a tared capsule. Product = total alkaloids of quinia, cinchonia, quinidia, &c. (All the alkaloids are soluble in chloroform.)

Treat the alkaloids with ether. Evaporate etherial solution. Product = amorphous and crystallisable quinia. Treat this for obtaining crystalline value as directed in the ether process.

The insoluble portion is then dissolved in dilute acetic acid, and treated with iodide potassium (sat. sol.); the precipitate, if any, is iodide of quinidia: can be estimated thus:—

100 grains = 71·68 quinidia
= 94·5 quinidia sulph.

The liquid treated with ammonia or soda gives a precipitate of cinchonia, which, when dried at 120° C., may be estimated as—

82 = 100 cinchonia sulphate crystals.

Another Method, although less accurate, is to digest in proof-spirit (alcohol 0·920 sp. gr.), which dissolves quinidia, and leaves undissolved the cinchonia and cinchonidine.

If these latter alkaloids are required in a quanitative crystalline form dissolve the residue, after treatment with ether, in a mixture of one volume of alcohol 0·795 and 9 vols. of ether; from this the quinidia will crystallise. The cinchonia can afterwards be crystallised from a saturated alcoholic solution.

To this process might be appended another, by percolation in the cold with alcohol. But as this process occupies considerable time in its first stage, it cannot be recommended for commercial purposes.

EXAMINATION OF THE NORTH CAROLINA URANIUM MINERALS.

By F. A. GENTH.

Prof. W. C. Kerr describes the occurrence of uranium in Mitchell County, North Carolina, as follows:*—"A new locality, the Flat Rock mine, recently visited, has yielded the following in immediate association, viz., uraninite, gummite, uraconite, and, as incrustations on the outside of the latter, and of the fragments of rock adjacent, torbernite and autunite. These minerals occur only in one part of the mica-bearing portion of a very large granite vein, and are found in irregular nodules and rounded masses, some with a nucleus of uraninite of ½ to ¾ inch, enveloped with a heavy layer of gummite, outside of which is a pale, yellow, earthy coating from ¼ to ⅛ of an inch thick, which is uranochre or uraconite. One lump, the largest, weighs just a pound, and in all, I obtained between 3 and 4 pounds. The quantity of pitchblende remaining unaltered is very small, and by far the greater part of the mass of the nodules, probably nine-tenths, is gummite; and the smaller ones are nearly or entirely changed to uraconite."

Through the kindness of Prof. Kerr I have recently come into possession of specimens of this highly interesting occurrence, which fully agree with the description above quoted. As his mineralogical determinations, however, were not supported by chemical analysis, and, especially as the composition of gummite is very doubtful, I thought that an investigation of the uranium minerals from this locality would be desirable.

I regret that of the uraninite no material for analysis could be obtained. One of my specimens of gummite, however, still contains one or two small fragments of uraninite; the larger one has a brownish black colour on the margin, changing into brownish, and, by degrees, into the pure gummite. It is also penetrated by small veins, showing the gradual alteration of the uraninite.

Uranotil.—E. Boricky.

The analysis of the pale yellow coating surrounding the gummite shows that it is a variety of *uranotil*, and *not*

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* *Am. Journ. Sci.* [3], xiv., 496.

uranochre or *uranoconite*. The original uranotil has been found in cavities of quartz, associated with fluorite, at Wœlsendorf, in Bavaria, in lemon-yellow rhombic needles, of a specific gravity of 3·95. For comparison I will give below Boricky's analysis of it.

The North Carolina variety is apparently amorphous; massive, compact. H = 2·5. Sp. gr. = 3·834. Lustre, waxy to dull; colour, from pale straw-yellow to lemon-yellow; streak, pale straw-yellow; opaque; fracture, uneven.

B. B. in a tube yields water, and becomes brownish yellow; with fluxes the uranium reactions. Easily soluble in chlorhydric acid; on evaporation yields a jelly of silicic acid.

The analyses gave, after deducting a small quantity of quartz, mica, and felspar:—

			Mean.	Boricky.	Calculated.
SiO_2	13·55	13·88	13·72	13·78	13·95
Al_2O_3,Fe_2O_3	traces	traces	traces	0·51	—
UO_3	66·76	66·59	66·67	66·75	66·98
PbO	0·74	0·45	0·60	—	—
BaO	0·28	0·48	0·28	—	—
SrO	0·13		0·13	—	—
CaO	6·23	7·11	6·67	5·27	6·51
P_2O_5	not det'd	0·29	0·29	0·45	—
H_2O	not det'd	12·02	12·02	12·67	12·56
		100·82	100·38	99·43	100·00

Rammelsberg* gives for uranotil the formula—

$$Ca_2(UO_2)_6Si_5O_{18}+15H_2O.$$

My analyses agree far better with the following formula— $Ca_3(UO_2)_6Si_6O_{21}+18H_2O$, as will be seen from the above calculated analysis. It forms an incrustation upon gummite and results from its alteration, sometimes (as has been observed by Prof. Kerr) changing the entire mass of the latter, and yielding nodules of pure uranotil; mostly, however, converting not only the outside of the gummite into uranotil, but penetrating its whole mass, so that even the purest particles contain already a large percentage of it, as will be seen from the analyses of the gummite.

Gummite.

The orange-coloured mineral from the Flat Rock mine has been called gummite, from its resemblance to that from European localities. It occurs in amorphous, compact, nodular masses. H = 3. Sp. gr. = 4·840. Lustre, faintly resinous to dull; colour, reddish yellow to deep orange-red; streak, orange-yellow; opaque; fracture, subconchoidal to uneven.

B. B. yields water and turns reddish brown; upon charcoal with sodium carbonate yields metallic lead; with fluxes gives the reactions of uranium. Easily soluble in acetic acid.

Below I give the analyses of the purest deep orange-red material, after deducting a minute quantity of quartz, felspar, and mica. For comparison I add the only analysis which is known of gummite, that from Johann-Georgenstadt in Saxony, by Kersten.

				Mean.	Johann-Georgenstadt.	Kersten.
SiO_2 ..	4·49	4·83	4·58	4·63	—	4·26
Al_2O_3 ..	0·67	0·40	[4·59]	0·53	Mn_2O_3	0·05
BaO ..	0·98	1·12		1·08	As,Fl	traces
SrO ..	0·05				—	—
CaO ..	1·96	2·14		2·05	—	6·00
PbO ..	5·48	5·58	5·64	5·57	—	—
UO_3 ..	[75·71]	75·50	74·39	75·20	—	72·00
P_2O_5 ..	0·12	0·07	0·16	0·12	—	2·30
H_2O ..	not det'd	10·43	10·64	10·54	—	14·75
		100·07		99·72		99·36

The opinion of chemists as to the composition of gummite is very much divided. Kersten thought it to be a combination of phosphate of lime with uranic hydrate, the composition of which he expressed by the formula—

$$3CaO,P_2O_5+4U_2O_3,9H_2O.$$

Berzelius considered it as a mixture of basic phosphate and basic silicate of uranic oxide and lime. Hausmann takes it to be principally the hydrate of uranic oxide. Rammelsberg expresses the same opinion, but believes that the analyses of gummite, together with those of eliasite and pittinite, represent mixtures, and that from their analyses no rational composition can be derived. Hermann, on the other hand, considers these and other uranium minerals, in which silicic acid has been found, even uraninite, as definite compounds of the formula— $4RO,SiO_2+4(4R_2O_3,SiO_2)+mH_2O+nX$. The accessory molecule X being wanting in pittinite, and in the other species represented by R(AsS) in uranochalcite, by $4RO,U_2O_3$ in uraninite, by CaO,CO_2 in eliasite, by $3CaO,P_2O_5$ in phosphor-gummite, and by $3CaO,(PV)_2O_5$ in vanadin-gummite. Hermann's views are as untenable as those of the others. Nearest to the truth, in my opinion, comes Patera, who holds that silicic acid and phosphoric acid are not essential, and that gummite is principally a lime-uranate, $CaO,2U_2O_3+6H_2O$, analogous in composition to the artificial uran-yellow.

Gummite is the result of an alteration of uraninite, and it seems to me that both pittinite and eliasite are intermediate between the two, containing more or less of either. But I have already pointed out the fact that the gummite from North Carolina is a mechanical mixture, and that uranotil penetrates the whole mass. The gradual change from gummite into uranotil can be observed on every specimen from this locality.

If we calculate from the SiO_2 in the gummite the requisite constituents of uranotil, making up the minute deficiency of CaO by its equivalent of BaO, we get:—

SiO_2	4·63
CaO	2·05
BaO	0·30
H_2O	4·17
	33·38 per cent of uranotil.

The PbO and BaO may be most rationally considered as being present in the form of $\overset{\prime\prime}{M}(UO_2)_2O_3+6H_2O$; we get therefore—

PbO	5·57
UO_3	14·39
H_2O	2·70
	22·66 per cent of lead-uranate; and

BaO	0·78
UO_3	2·93
H_2O	0·55
	4·26 per cent of barium-uranate.

There remain 35·65 per cent of UO_3, which is evidently present as uranic hydrate, requiring 4·45 per cent of water.

The gummite from the Flat Rock mine is therefore a mechanical mixture of:—

Uranic hydrate, $H_2(UO_2)O_2+H_2O$	40·10 p.c.
Uranotil, $Ca_3(UO_2)_6Si_6O_{21}+18H_2O$	33·38 ,,
Lead-uranate, $Pb(UO_2)_2O_3+6H_2O$	22·66 ,,
Barium-uranate, $Ba(UO_2)_2O_3+6H_2O$ ..	4·26 ,,
	100·40

The analyses of pittinite and eliasite admit of no calculation, as they appear to have too many foreign substances present, and as the amount of uranous oxide which they evidently contain has not been determined; if we take the analysis of gummite from Johann-Georgenstadt, we find it probably to be a mixture of calcium-uranate, with uranotil, a uranium-phosphate (phosphuranylite), and uranic hydrate. These calculations give the following amounts:—

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* *Mineralchemie*, 692.

SiO_2	4·26
UO_3	20·45
CaO	1·99
H_2O	3·84
	30·54 per cent of uranotil.
CaO	4·01
UO_3	41·25
H_2O	7·73
	52·99 per cent of calcium-uranate.
P_2O_5	2·30
UO_3	4·68
H_2O	1·75
	8·73 per cent of phosphuranylite.
UO_3	5·62
H_2O	0·70
	6·32 per cent of uranic hydrate.

The gummite from Johann-Georgenstadt has therefore probably the following composition, corresponding with Kersten's analysis :—

Uranic hydrate, $H_2(UO_2)O_2+H_2O$	6·32 p.c.
Uranotil, $Ca_3(UO_2)_6Si_6O_{21}+18H_2O$ ..	30·54 „
Phosphuranylite, $(UO_2)_3P_2O_8+6H_2O$ ..	8·73 „
Calcium-uranate, $Ca(UO_2)_2O_3+6H_2O$ ..	52·99 „
	98·58

Phosphuranylite.—A new species.

Rhombic (?). Under the microscope very minute rectangular scales with pearly lustre can be distinguished. In pulverulent incrustations upon quartz, felspar, and mica. Colour, deep lemon-yellow.

B. B. in the tube yields water and becomes reddish brown while hot, brownish yellow after cooling; readily soluble in nitric acid, yielding with ammonium molybdate a yellow precipitate; contains *no* arsenic acid.

As this mineral is very rare, only a very minute quantity could be obtained which was free from autunite; this being in the form of a thin coating upon quartz, both together had to be taken as material for analysis.

0·6705 grm. contained 0·5617 grm. quartz—the analysis was therefore made with 0·1088 grm. of material. This was slightly mixed, probably with cerussite, which was visible under the microscope in the form of very small colourless particles. In the first column I give the results of the analysis, in the second the percentage of the phosphate, excluding the lead oxide, and in the third the calculated percentage, corresponding to the formula given below.

			Calculated.
UO_3	71·73	76·71	77·56
PbO	4·40	—	—
P_2O_5	11·30	12·08	12·75
H_2O	10·48	11·21	9·69
	97·91		

It will be seen from this analysis that the uranium and phosphorus are present exactly in the ratio of 3 : 2, and that the composition of phosphuranylite may be expressed by a formula analogous to that of troegerite, but containing only half the amount of water :—

Phosphuranylite = $(UO_2)_3P_2O_8+6H_2O$,
Troegerite = $(UO_2)_3As_2O_8+12H_2O$.

Prof. Kerr mentions torbernite as one of the uranium minerals from the Flat Rock mine, and he sent me some uranite, which had a deep green colour and resembled it very closely; but the chemical examination of one of the darkest green crystals showed that it contained only lime, and not a trace of copper oxide, and that the uranite from this locality is therefore only autunite.—*American Chemical Journal.*

THE SIEMENS LIGHT AT THE BRITISH MUSEUM.

On Monday, the 20th inst., at 6 o'clock in the evening, a select party of officials, scientific men, and members of the press assembled in the Reading Room of the British Museum for the purpose of testing the new plan of lighting that building by the electric light as carried out by Messrs. Siemens, the electrical engineers. The main difference between the method adopted by Messrs. Siemens and that experimented upon by the Société Générale d'Electricité consists in the use of four very powerful lamps hung high over the heads of the readers, instead of a number of less powerful lights at a lower elevation. Two different systems of lighting are adopted, one for the Reading Room, and the other for the passages, hall, and court yard. The Reading Room is lighted by four lights of 5000 candle-power each, one being in the middle of the circle, and the other three arranged round it at equal distances in the form of an equilateral triangle. These four lights are produced by continuous currents passing through wires carried over the roof of the Reading Room and through the top of the glass lantern in the centre of the dome. The electricity is supplied by five dynamo-electric machines placed in a shed at the back of the Museum buildings at about 200 yards distance, and worked from two 8-horse-power semi-stationary engines, supplied by Messrs. Wallis and Steevens, of the North Hants Iron Works, Basingstoke.

The Reading Room regulators are the invention of Messrs. Siemens and Halske, of Berlin, and on Monday week they appeared to do their work thoroughly if we except a very unpleasant crepitation now and then, which a scientific man present aptly compared to the rale of a typhoid fever patient. There is also an occasional purple glow for a few seconds caused no doubt by some potassic impurity in the charcoal. These regulators are of a sufficiently simple kind and may easily be managed even by unexperienced hands. They each contain 19 inches of double carbon, which are consumed at the rate of 3 inches an hour. The lights consequently will burn for a little more than six hours without the regulators being interfered with. The other seven lights, of which two are placed in the Court Yard, one under the portico, one in the Hall, one in the passage leading to the Reading Room, one in the Sculpture Gallery, and the remaining one in the engine house, are worked by alternate current machines, and the regulators are actuated by two coils acting on a differential principle, one of them forming part of the main circuit and tending to separate the carbons, the other tending to bring them into contact. The position of the carbons depends therefore not upon the strength of the current, but upon the relative amount of electricity passing through each coil. These regulators are worked by two alternating current machines and are all in one circuit, the length of which is about 1200 yards, their construction being such that if one becomes extinguished either from accidental breakage or from want of carbon it does not affect the others. The carbons in these lamps burn for about five hours, and may be renewed in half a minute. The wires supplying the current for these regulators are laid partly in the basement of the building, and partly in pipes under the ground. The light given out by each of these lamps is equal to 600 candles, and their steadiness says much for the excellence of the principle upon which they are constructed.

The light from the lamps in the Reading Room passes through an opal glass lantern in the shape of an inverted truncated pyramid, a very small amount of the upward rays being thrown downwards by a circular reflector of opal glass. It is a singular fact that most gas and electrical engineers seem to take it for granted that this material is one of the best possible reflectors. For softening a too brilliant light it is unequalled, but its use as a reflector is almost *nil*. In the very powerful lamps erected by Messrs. Sugg in Waterloo Road and Waterloo Place, the upper portion of the lantern consisted of a hollow pyramid of opal glass, which absorbed nearly the whole of the upward rays, while the small amount reflected downwards were thrown into the wrong place. In the present instance the whole of the light thrown upwards is lost with the exception of the very small proportion which is thrown down by the flat opal glass reflectors placed above the lamps.

The best method of distributing the electric, or indeed any very powerful light, over a given area has yet to be devised. The problem is a very simple one, but this is not the place for its solution. A proper knowledge of the most elementary laws of reflection will show that the plans at present in use are wrong in principle and involve a serious waste of lighting power.

The powers of the light were severely tested by several of the gentlemen present. Mr. George Bullen, the Keeper of the Printed Books, put it to several practical working tests in different parts of the room, and found that at the desks which are farthest from the centre there was a decided lack of light for those who, like Mr. Bullen, have somewhat impaired their sight by incessant literary labour, while at the catalogue desks and in the centre of the room, the light was much more than sufficient to read even the smallest print. He consequently made a most valuable suggestion to Dr. Siemens, which met with the immediate approval of that gentleman and of all present. The diameter of the Reading Room it will be remembered is exactly 140 feet, the half of which is 70 feet. As at present placed the three outer lamps hang at a distance of about 35 feet from the centre, and of course at an equal distance from the wall. A moment's consideration will show that according to this arrangement the central portion of the room gets an overplus of light, while the part near the wall is underlighted. Mr. Bullen consequently very properly suggested that the three outer lamps should be hung at a distance from the centre of two-thirds of the radius of the circle, by which means each third of the line between the centre and the circumference would be equally illuminated. By moving the outer lamps nearer the wall the outer row of the catalogues will be taken out of the deep shadow in which they were thrown by the arangement adopted on Monday; it is to be hoped, therefore, that Mr. Bullen's suggestion will be carried into effect.

Dr. Carter Blake submitted the purity of the light to some very searching colour-tests, and found that the most delicate tints were as easily distinguishable as in bright daylight. This will be good news for those artistic workers who are so frequently rendered compulsorily idle during dark, or, worse still, yellow weather.

When the modifications indicated above are carried out there will be no possibility of doubting the thorough practicability of lighting the British Museum Reading Room by electricity, and readers of all classes will owe a heavy debt of gratitude to Mr. Bond for the persistency which he has shown in carrying out this vast improvement.

An important factor in the success of the experiment must be looked for in the engines supplied by Messrs. Wallis and Steevens, which work in an exceptionally steady manner, an advantage which is due to the use of an extremely sensitive form of governor, which keeps them at a uniform rate of speed, thereby securing almost perfect steadiness in the lights. Good as it is this form of governor has been further improved upon by Messrs. Wallis and Steevens. This new form of governor will be applied to the British Museum engines as soon as it has been thoroughly tested at Basingstoke. The peculiarity of the new governor lies not so much in its steadiness as in its allowing the engineer in charge to increase or diminish the normal speed of the engine at pleasure, according as the lights require it, and then to maintain with perfect regularity the particular speed which is found in practice to give the best light.

The best way of throwing down the upwards rays, most of which are now lost, should form the subject of serious experiments. One thing is certain: opal glass is about the worst reflecting material that can be adopted. The dark colour of the interior of the Reading Room—the natural result of a long course of London fog and smoke—also causes a great waste of light. This is, however, a defect that can be very easily altered at a comparatively small expenditure of money and trouble.

In conclusion we must congratulate Mr. Bond on having carried his experiments to such a successful issue. In consequence of this success the Reading Room has been thrown open to readers every evening up to seven o'clock since Wednesday, the 22nd inst., and will continue open up to that hour until further notice. There is only one opinion amongst the readers as to the general efficiency and convenience of the light. It may be as well to mention that no books from the large library can be taken out after half-past four, but books already in the possession of readers before that hour may be kept until half-past six. The interior of the library not being lighted is the obvious reason for this regulation. The Library of Reference in the room itself is of course available up to closing time.

CORRESPONDENCE.

DISSOCIATION OF CHLORINE.

To the Editor of the Chemical News.

Sir,—A more careful reading of the few words from me under the above heading in the Chemical News, No. 1034, would make it perfectly clear that I did not confound the platinic and platinous chlorides, as suggested by Mr. Watson Smith in the Chemical News, No. 1035.

The presumption is that an investigator of such standing as Prof. V. Meyer, has taken all suitable precautions; yet in the case of so important a discovery as that in question, of which at the the time of writing my only information was derived from the notice in Chemical News, No. 1027, any possible and less obvious source of error may well be brought to notice. And the question still remains, and is pertinent to such of V. Meyer's experiments as were made with platinous chloride; may not platinous as well as platinic chloride, the former presumably made from the latter, retain a portion of the compounds of oxygen and nitrogen at a temperature above that at which the lower chloride begins to be decomposed? assuming the original source to be as usual platinum and aqua regia, the solution afterwards repeatedly evaporated with hydrochloric acid and water. In the experiments of mine referred to, which were necessarily made under pressure, there was nothing to show that at such temperature oxygen compounds had ceased to be given off.—I am, &c.,

F. P. Dunnington.

FLUID MEDIUM FOR IMMERSION LENSES.

To the Editor of the Chemical News.

Sir,—I find from conversation with those who have worked with the new "Homogeneous Immersion" (Oil Immersion) Lenses, that a better fluid medium is a desideratum. The essential oil used is too mobile, and consequently difficult to keep in its place between the front lens and the object, besides acting injuriously on some of the mounting varnishes.

Optically it answers well enough. The medium to be perfect should be of the same refractive and dispersive power as crown-glass,—thick enough to keep its place between the object-glass and the cover, not liable to evaporate rapidly or deposit crystals. Should not act upon glass, metals, or the usual cements employed in mounting objects.

As the introduction of these objectives—which certainly have great advantages optically—can hardly become general until a better medium is obtained, may I ask you to direct, as far as you are able, the attention of chemists to the subject? A suitable fluid may probably be easily attainable, but opticians and microscopists are probably the persons least likely to discover it.

The metals employed in mounting objectives are either brass or an alloy of nickel; platinum is not sufficiently rigid to bear turning to a thin edge.—I am, &c.,

W. T. Suffolk.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 15, October 13, 1879.

The Present State and the Future of Thermo-Chemistry.—M. Berthelot.—The author gives a history of thermo-chemistry and explains the plan of his new work, "Essay on Chemical Mechanics founded upon Thermo-Chemistry." The first volume of this work is devoted to calorimetry, that is to say, the measurement of the quantities of heat set in action in chemical processes. The second volume comprises the general study of chemical composition and decomposition, especially that of systems in equilibrium between two contrary tendencies. The remainder of the work is devoted to chemical statics.

Production of a New Manure.—M. de Molon.—The author mixes finely-ground phosphate of lime with sea-weeds, especially varec, and allows the mass to ferment for six to eight weeks.

Experiments on the Electric Discharge of the Chloride of Silver Battery.—MM. Warren de la Rue and H. W. Müller.—This paper has also appeared in English.

Action of Metallic Nitrates upon the Monohydrated Nitric Acid (see *Comptes Rendus*, lxxxix., 576).—A. Ditte.—There exists a group of nitrates which behave like magnesium nitrate; under the influence of heat they melt in their water of crystallisation which escapes along with the nitric acid, whilst a matter remains which still contains water in quantities more or less considerable, neutral nitrate, and either a sub-nitrate (zinc nitrate) or an oxide (manganese nitrate). In contact with the monohydrated acid the sub-salts are transformed into neutral nitrates, setting at liberty a certain quantity of water. The nitrates belonging to this group are those of magnesia, manganese, zinc, alumina, iron, copper, and uranium. Sub-nitrates are obtained from all of these metals except manganese, alumina, and iron. A third and numerous group, such as those of sodium, lithium, lime, barium, strontium, nickel, cobalt, bismuth, cadmium, mercury, silver, and lead, are insoluble or very sparingly soluble in the acid, at any temperature soever.

Silicium Nitride.—P. Schutzenberger.—The author finds that there exist two nitrides of silicon; the one SiN, corresponding to cyanogen and titanium nitride, the other being very probably Si_3N_4. The products resulting from the action of ammonia upon silicon chloride are again distinct, and contain either chlorine and hydrogen, or hydrogen alone. Their formulæ are $\text{Si}_8\text{N}_{10}\text{Cl}_3\text{H}$ and $\text{Si}_2\text{N}_3\text{H}$.

Les Mondes, Revue Hebdomadaire des Sciences. No. 2, September 11, 1879.

This issue contains no original chemical or physical matter. There is an article on the *Splendeurs de la Foi*, and an attack upon the French Government for wishing to keep in its own hands the right of granting academical degrees.

No. 3, September 18, 1879.

Vines Reviving.—Certain vines at Neuvic (Charente Inférieure) supposed to be dead and about to be torn up have shot out afresh this year, and display a magnificent vegetation.

Trichinosis at Berlin.—Very stringent regulations have been adopted at Berlin to prevent the sale of trichinised pork. Every pig killed must be submitted to microscopic examination under a penalty of from 3 (*sic*) to 30 shillings.

No. 4, September 25, 1879.

This issue contains no matters of chemical interest.

No. 5, October 2, 1879.

Sophistication of Food and Drugs.—A statement is quoted from the New York *Popular Science Monthly* that a Boston chemist found in a sample of cream of tartar 75 per cent of *terra alba*, and that at Chicago, a chemist, in want of antimony sulphide, could find in the shops merely marble dust blackened with soot.

The Louis Maiche Battery.—The elements of this battery are platinised coke and amalgamated zinc, the latter placed in a solution of sal-ammoniac and the former plunging only slightly in the liquid, so as to present a large surface to the air.

Researches on the Movements of the Magnetic Needle.—E. Quetelet.—This memoir gives an account of the magnetic observations made at Brussels; a new study on the secular movements of the needle at the same locality, and a notice of the various movements which the needle experiences from different causes.

Researches on the Compressibility of Gases at High Pressures.—E. H. Amagat.—Already noticed.

Action of Ozone on the Colouring-matters of Plants.—A. Leeds.—Taken from the Chemical News.

New Method of Preparing Bleaching Liquid.—Chloride of lime is decomposed with excess of bicarbonate of soda. The sediment subsides very easily.

No. 6, October 9, 1879.

Tempered Glass.—M. de la Bastie is said to have made great improvements both in the method of tempering glass and in the quality of the product. Among the articles shown to the Société d'Encouragement are mortars with their pestles for chemical use.

Production of Dew.—Prof. Levi Stockbridge.

Action of the Sun upon Galvanic Batteries.—Ph. Delahaye.—Already noticed.

Thermo-electric Battery.—M. Clamond.—A new battery for the production of the electric light. With a consumption of 9½ kilos. coke, a current is produced capable of maintaining 4 lamps, each equal to 25 Carcel burners.

Researches with the Audiometer of Hughes.—B. W. Richardson.

Magnitude of Molecules.—D. C. Hodges.—These two papers are from an English source.

Influence of Atmospheric Electricity on the Growth, Inflorescence, and Fructification of Plants.—C. Naudin.—Already noticed.

Electro-motive Force in Free Jets of Water.—M. Elster.—Contrary to the assertions of Edlund, the friction of liquids against themselves produces no trace of electricity. If a jet of liquid is directed against a plate of some non-conducting substance, electric action is manifest. The currents observed in capillary tubes are due to the friction of the liquid against the sides.

Emission Spectra of the Haloid Compounds of Mercury.—B. Pierce.—On passing the spark into Geissler tubes containing a little of the salt and heating progressively, there is observed first the spectrum of the air, then that of the salt, and finally that of mercury. The chlorides give the same band between orange and green; mean wave-length $\lambda = 443$, which seems to indicate a dissociation of $HgCl_2$ into $HgCl$ and Cl. The bromide gives a band $\lambda = 500$; the iodide, $\lambda = 558$.

Influence of the Intensity of Sound upon the Speed of its Propagation.—H. Kayser.—The speed of sound in the free air is not affected by its intensity.

Electrolysis of Water.—M. Flaner.—An electrolyte is always decomposed by a current, however feeble; but permanent decomposition only begins at the moment when the primary current is superior to the constant intensity of the polarisation current.

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. No. 7, 1879.

Chemistry at the Paris Exhibition.—Prof. C. Liebermann.—The author gives a review of the condensation of the so-called permanent gases; of the new element gallium, whereby he remarks that its identity with the theoretical "ekaaluminium" of Mendelejeff is not yet absolutely demonstrated; of the artificial jewels of Fremy and Feil, of Solvay's soda, the concentration of sulphuric acid, the fusion of platinum, tempered glass (the value of which he considers limited), the utilisation of kelp, lighting materials, the utilisation of beet-root treacle, and artificial colouring-matters. The industrial manufacture of artificial indigo he does not consider as near at hand.

La Correspondance Scientifique.
No 65, October 21, 1879.

Remedy against Rabies and the Bites of Serpents.—M. Torrès Caicedo calls attention to the guaco and the cedron, two South American plants, as antidotes to the bites of serpents.

Die Chemische Industrie.
No. 8, August, 1879.

A considerable space is again devoted to a report of the debates in the German reichstag on the protective duties to be imposed upon chemicals.

Injury to Vegetation from Acid Vapours (Conclusion).—R. Hasenclever.—The author remarks that "in German towns which depend on the concourse of travellers, in watering places, &c., permission for the erection of industrial establishments is justly refused. [This is the principle which has been repeatedly advocated in the Chemical News that in certain districts the restrictions on the pollution, both of the atmosphere and of rivers, should be very severe, whilst in others considerable latitude may be allowed.] According to a private communication received by M. Hasenclever from Mr. Fletcher, the weekly quantity of noxious gases discharged into the atmosphere at St. Helens is as follows:—

Gaseous products of fuel	800	tons	SO_2.
From copper works	380	„	„
From glass works	180	„	„
From chemical works	25	„	HCl.

In the neighbourhood of Ludwigshafen the plum trees are the only kind of vegetation apparently injured by the acid fumes.

Reimann's Färber Zeitung,
No. 36, 1879.

This issue contains nothing of general interest.

Revue Universelle des Mines, de la Metallurgie, &c.,
Tome 5, No. 3, May and June, 1879.

Study on the Influence of the Heat of the Interior of the Earth on the Possibility of Constructing Tunnels through High Mountains.—Dr. F. M. Stapff.—The author proposes the following questions:—(1.) At what degree of temperature will underground work be rendered impossible on physiological grounds? (2.) At what depth of a tunnel below the surface may the occurrence of such a temperature be expected? After consulting Prof. Dubois Reymond and instituting experiments at his recommendation in the St. Gothardt tunnel, the conclusion is drawn that it is possible to work for a short time at 60° in a dry atmosphere, but that if the air is saturated with moisture 40° is the limit. The author considers that the products of the explosion of dynamite in mines may include nitric acid and carbonic oxide. Particles of nitroglycerine are also held in suspension in the smoke, and occasion head-ache, indigestion, and other distressing symptoms. The second question will be discussed in a continuation of this metal.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.
No. 68, August, 1879.

This issue contains no chemical matter, and is chiefly devoted to an account of the calculating machine (arithmometer) of M. Thomas.

Justus Liebig's Annalen der Chemie,
Band 198, Heft 3.

Action of Elevated Temperatures and the Vapours of Carbolic Acid upon Organic Bodies.—Carl von Than.—During the outbreak of the plague in Russia the Hungarian sanitary authorities required that all substances imported from suspicious districts should be submitted to the joint action of high temperatures and the vapours of phenol, and the author was officially instructed to examine experimentally the action of this process of disinfection. He found that the conduction of heat through packets of letters, &c., was very slow. A packet of 22 letters was placed in an air-bath maintained at 111°. After four hours the temperature in the middle of the packet did not exceed 100°, whilst in a larger packet of 70 letters similarly treated the heat only rose to 75°. For practical purposes the letters were laid loosely in a wire basket, with a sheet of tin-plate or wire gauze between every ten, and in this manner any number of letters could be brought in two hours to the temperature of 148°. The second question was, What is the highest temperature which organic matter, especially paper, can bear without injury? It was found that in an air-bath, where the action of radiant heat was excluded, decomposition set in between 150° to 160°, but that at 140° no essential change took place. If exposed to the vapours of crystallised phenol at temperatures of from 130° to 140°, neither the paper nor the writing was injured. Filter and litmus paper, cotton, various kinds of linen, white and dyed tissues of wool and silk, lace, raw wool, and leather were not injured, either by the action of heat alone or by exposure to phenol vapours at 138°. Exceptions must be admitted in case of white wool, which was turned rather yellowish, and of wash-leather, which condensed a considerable quantity of phenol and became brittle. The action of heat alone and conjointly with phenol vapours was next studied. It was found that a dry heat of 137° delayed putrefaction, but did not suffice for the total destruction of all kinds of Bacteria. But a temperature of 137° applied along with the vapours of phenol completely eradicated all living organisms. These conclusions, therefore, confirm the experimental results of the late Prof. Crace-Calvert.

Determination of the Solubie Phosphoric Acid in Superphosphates.

I. *Commercial Superphosphates.*—E. Wein, L. Rœsch, and J. Lehmann.—The process of determining phosphoric acid as agreed upon in 1872 by the agricultural chemists of North Germany, at the Magdeburg conference, having been called in question, the authors have submitted it to re-examination, and consider that the variation in its results is mainly due to differences in the method of preparing an aqueous extract of the sample. The process adopted at the Conference is as follows:—20 grms. superphosphate are stirred up with water in a mortar; the lumps broken without too great pressure, and the whole rinsed into a litre flask. So much water is then added that the liquid can be conveniently shaken, and digested for a time. If little iron and alumina is present the digestion was prolonged for two hours, but if these impurities were abundant the liquid was filtered off immediately after a careful agitation. After a very extensive series of experiments, the authors conclude that a digestion of two hours is not injurious in presence of ferric and aluminous phosphates; that the lixiviation of the sample upon a filter with the aid of the Bunsen pump offers no advantages over the method above described, and that the quantity of water generally used (1 litre to 20 grms.) is perfectly sufficient.

II. *Superphosphates from Chemically Pure Material.*—E. Wein.—The principal results are:—In superphosphates containing much free phosphoric acid, a very brief digestion is sufficient. In such cases the lixiviation process gives accurate results, though it is not to be recommended. Superphosphates containing but little free phosphoric acid should be digested for two hours to make sure that all soluble phosphates are extracted. In such cases the lixiviation method is not applicable. Superphosphates containing no free phosphoric acid must likewise be digested for two hours with a litre of water, but a further increase of the quantity does not seem serviceable.

Separation and Determination of Manganese.—J. Volhard.—(See p. 207.)

Heptan from Pinus Sabiniana.—T. E. Thorpe.

Derivatives of Isodurol.—Max Bielefeldt.—Not adapted for abstraction.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. No. 11, 1879.

Separation of Ortho-xylol from its Isomers, and on a New Xylidin.—E. Wroblevsky.—Xylol is nitrised and reduced, yielding a mixture of the isomeric xylidins, the derivatives of meta- and ortho-xylol. The mixture is heated for three days with an equivalent quantity of glacial acetic acid. On submitting the mass to fractionated distillation the portion passing over up to 310° consists of water, acetic acid, and unchanged xylidin acetate. Above 320° acetxylid distils over, fusible at 127°. It is a derivative of metaxylol. The portion which went over below 310° is treated with soda-lye; when much unchanged xylidin floats upon the surface, which is distilled over with watery vapour and again heated with glacial acetic acid, after which it no longer congeals. This portion is again submitted to distillation when the derivative passing over above 320° crystallises readily, and consists of a mixture of acetxylids. The xylidin separated from the portion boiling at a lower temperature was found to be a derivative of orthoxylol.

On Protagon.—A. Gamgee and E. Blankenhorn.—The authors have been able to confirm the statements of Liebreich, both as regards the chemical and physical properties of protagon.

Formyl-tricarbonic Ester.—M. Conrad.—Formyl-tricarbonic ethyl-ester is a colourless liquid of pleasant odour, insoluble in water, volatile between 254° to 260°, of sp. gr. 1·10 at 19°, and having the composition $C_{10}H_{16}O_6$.

Reply to H. Kraut.—H. Kœhler.—The author maintains the accuracy of his observations on the melting-point of mercuric chloride.

Ellagic Acid.—L. Barth and G. Goldschmiedt.—In this very extensive memoir the authors endeavour to ascertain the constitution of ellagic acid and for this purpose they examine its behaviour with lime or soda-lime, with hydriodic acid, with hydrochloric acid, with caustic potassa, and with caustic soda. Summing up all their observations they think ellagic acid ought to be called "hexa-oxidiphenyl-keton-carbonic anhydride."

Action of Melting Soda upon Aromatic Acids.—L. Barth and J. Schreder.—As a rule these acids, when treated with melting potassa, are decomposed with elimination of carbonic acid. It was not found possible in this manner to arrive at more highly hydroxylised derivatives, as is the case with certain phenols.

Derivatives of α-Disulpho-phenolic Acid.—L. Barth and M. v. Schmidt.—Among the results obtained is the preparation of the sodium and the barium salts.

Disulpho-resorcic Acid.—V. Tedeschi.—This acid is soluble in water and alcohol, insoluble in ether. The aqueous solution yields a splendid ruby-red colouration with ferric chloride. Its composition, according to the author, is $C_6H_2(SHO_3)_2OH_2+2H_2O$.

Action of Phosphorus Penta-chloride upon Saccharic Acid and Saccharine Bodies.—C. J. Bell.—After examining the behaviour of phosphorus penta-chloride upon saccharic acid, mannit, and dulcit, the author concludes that the formation of chlor-muconic acid is no isolated fact, and that the isomeric saccharic acid and the corresponding kinds of sugar show a concordant behaviour.

A Correction.—S. Hoogewerff and W. A. van Dorp.—The authors used 8·5 to 9·5 grms. potassium permanganate not to 16 grms., but to 1 grm. dry quinine sulphate. See *Berichte*, xii., p. 158.

Constitution of Anthrarufin and Oxy-anthrarufin.—C. Liebermann and J. Dehnst.—Not suitable for abstraction.

Exsiccator for Carbon Disulphide, Ether, Chloroform, and Benzol.—C. Liebermann.—For the evaporation of these solvents the author charges a common exsiccator with fragments of crude paraffin instead of sulphuric acid.

Certain Derivatives of Ortho-nitranilin.—Ch. Rudolph.—The author dissolved ortho-nitranilin in chloroform, and heated the solution in a cohobator along with chloro-carbonic ether. Among the products formed was ortho-nitrophenyl-urethan.

On Benzylamin.—Ch. Rudolph.—A preliminary notice on the derivatives of benzylamin.

On Chlorinised Metallacetic Ethers.—F. Allihn.—An account of the preparation and properties of cupro-acetmono-chloracetic ether.

A New Double Salt of Chromic Acid.—C. Hensgen.—On adding a concentrated solution of neutral potassium chromate to one of ferric chloride as long as a precipitate is formed, and dissolving the latter in the necessary quantity of hydrochloric acid, a deep red solution is obtained, which in a few days deposits crystals of the new compound, $K_2CrO_4,Fe_2(CrO_4)_3,4H_2O$.

On Para-diethyl Benzol from Para-dibrom Benzol.—H. Aschenbrandt.—An account of mono-sulpho-para-diethyl benzolic acid and mono-nitro-para-ethyl benzoic acid.

Action of Organic Zinc Compounds upon Quinons.—F. R. Japp.—In this paper the author describes the action of zinc-ethyl upon phenanthren-quinon.

On a Remarkable Decomposition of Phenyl-ethylamin Hydrochlorate—M. Fileti and A. Piccini.—If the hydrochlorate of phenyl-ethylamin is heated to a boil in a fractionating flask, a small quantity of styrol distils over.

Researches on the Group of Indigo Blue.—A. Baeyer.—This memoir treats on hydro-isatin, indophenin, brom-indophenin, nitro-isatin, nitro-oxindol, retinindol, nitro-indigo, and amido-indigo.

Synthesis of Chinolin.—A. Baeyer.—The author has obtained dichlor-chinolin from hydrocarbo-styril, and has then reduced the former compound to chinolin.

On Ultramarine.—A. Rinne.—Ultramarine is defined as a sodium-aluminium silicate holding in solution a variable mixture of sodium sulphide and oxy-salts of sulphur.

Isatin and its Derivatives.—W. Suida.—An account of acetyl-dioxindol and acetoxindol.

Action of Chloro-carbonic Ether upon Mono- and Di-amylamin.—E. Custer.—The compounds here investigated are mono-amyl-carbaminic ethyl-ether, amyl-cyanate, mono-amyl-urea, di-amyl-urea, tri-amyl-urea, tetra-amyl-urea, di-amylamin, and di-amyl-carbamic ethyl-ether.

On Aldehydo-oxybenzoic Acids from Metoxybenzoic Acid.—F. Tiemann and L. Landshoff.—The authors describe the action of chloroform upon alkaline solutions of metoxybenzoic acids, ortho-aldehydo-metoxybenzoic acid, the formation of oxyterephthalic acid from ortho-aldehydo-metoxybenzoic acid, and also paraaldehydo-metoxybenzoic acid.

The Mutual Relations of the Xylenols, Homo-oxybenzyl Alcohols, Oxytoluyl Aldehyds, Oxytoluylic Acids, Alcohol-oxybenzoic Acids, Aldehydo-oxybenzoic Acids, and Oxyphthalic Acids.—F. Tiemann.—Not capable of useful abstraction.

On Diethyl- and Diamyl-anhydro-benzoyl-diamido-benzol Compounds.—H. Hübner and E. Simon.—A brief account of diethyl-anhydro-benzoyl-diamido-benzol tri-iodide, diethyl-anhydro-benzoyl-diamido-benzol iodide, diethyl-anhydro-benzoyl-diamido-benzol hydroxide, diethyl-anhydro-benzoyl-diamido-benzol chloride, and the corresponding platino-chloride, sulphate, and nitrate, and also of diamyl-anhydro-benzoyl-diamido-benzol and its derivatives parallel to those of the diethyl-series above mentioned.

Nitro-salicylic Acids and Dinitro-phenols. — H. Hübner, S. M. Babcock, and H. Schaumann.

Iodsalicylic Acids and other Derivatives of Hydroxybenzoic Acids.—H. Hübner.—These two papers are not suitable for abstraction.

Preparation of Sulpho- or Sulphi-Compounds from Diazo-Compounds with Sulphurous Acid.—F. H. S. Müller and F. Wiesinger.—The authors have obtained the sulpho- or sulphi-toluolic acids from the corresponding diazo-compounds with sulphurous acid.

Tolyl-Mustard Oils.—G. Lachmann.—The author has examined the action of chlorine upon ortho-tolyl-mustard oil.

On Phosphorus Sulphides.—G. Ramme.—The phosphorus disulphide is found to be not PS_2, but P_3S_6. The author obtained P_4S_3 both from common and from red phosphorus.

A New Method of Formation of Methyl-violet.—H. Hassencamp.—If 1 part of pure benzol-sulpho-chloride is mixed with 2 parts of dimethyl-anilin and heated in a flask upon the water-bath, a deep blue colouration soon appears, which becomes more intense and takes a more violet tone. In a few hours the whole becomes a pasty, dark mass, of a metallic lustre. There is no escape of gas, and the reaction is exceedingly regular. The behaviour of the colouring-matter thus formed, especially with organic fibres, which it dyes in fine violet-blue shades, renders it probable that methyl-violet has been formed. It is possible that other sulpho-chlorides react in a similar manner with aromatic bases. Benzol sulpho-chloride and methyl-phenyl-amin yield in an analogous manner a blue colour, soluble in alcohol, which appears closely similar to ordinary diphenyl-amin blue.

Picric Ether.—C. Willgerodt.—The author has examined the formation and properties of picric ethyl-ether, picric phenyl-ether, and the formation of ethyl-ether, by the action of potassium hydroxide upon a mixture of ethyl-iodide and ethylic alcohol.

Arseniates of Zinc and Cadmium.—W. Demel.—The author has prepared and examined the mono-arseniate with 2 mols. crystalline water, $2ZnOAs_2O_5 3H_2O$. This salt, on treatment with water, loses arsenic acid, and yields a new crystalline salt, $10ZnO.4As_2O_5.10H_2O$. The hydrochloric solutions of both these salts yield, on the addition of alkalies, a white bulky precipitate, the neutral arseniate, $3ZnOAs_2O_5+3H_2O$. The cadmium arseniates are quite analogous.

Determination of the Vapour-densities of Certain Inorganic Compounds.—V. and C. Meyer.—The results communicated are antimonious acid, 19·60; cuprous chloride, 6·93, and cadmium bromide, 9·22.

Quantitative Determination of Starch in Sausages.—L. Medicus and E. Schwab.—The authors treat the sausage with diastase, invert the mixture of maltose and dextrins with a little sulphuric or hydrochloric acid, and determine the grape-sugar thus obtained in the usual way.

Biedermann's Central-blatt für Agrikultur-Chemie.

October, 1879.

Various Manurial Matters.—Prof. J. Moser.—The sylvin from Kalusz contains about 18 per cent of potassium chloride. Kainit, from the same locality, contains only 8 per cent of actual potash. The "coral ore" of Idria, after removal of the mercury, contains from 4 to 29 per cent of phosphoric acid combined with lime. The sewage process of Forbes and Price, formerly in use at Hertford, is said to be working successfully in Grätz, where the effluent contains 0·14 to 0·24 per cent of nitrogen, 0·86 to 1 per cent of total solids in solution, and *no* phosphoric acid. The composition of the original sewage is unfortunately not given. Fish guano from Trieste, prepared from the heads and entrails of sardines, contained 5·58 per cent nitrogen, and 6·29 phosphoric acid. Dried blood, a residue from the manufacture of albumen, contained on an average 12 to 13 per cent of nitrogen, and 0·9 per cent o phosphoric acid.

Proportion of Oil in the Seeds of Certain Grasses.—Dr. H. Breiholz.—The proportion of oily matter in these seeds varies greatly.

Ripening of Grapes.—C. Portele.—Not suitable for abstraction.

MEETINGS FOR THE WEEK.

Monday, Nov. 3rd.—Royal Institution, 5. General Monthly Meeting.

Thursday, 6th.—Chemical, 8. "On Alizarin Blue," by G. Auerbach. "The Transformation-products of Starch," by C. O'Sullivan. "Note on the Formulæ of the Carbohydrates," by H. E. Armstrong. "A New Method of Determining Sulphur in Coal," by T. Nakamura. "The Bromine Derivatives of β-Naphthol," by A. G. Smith. "Notes on the Dissociation of Ammonia-iron Alum," by J. S. Thomson.

Saturday, 8th.—Physical, 3. "On a Standard Cell," by Captain Armstrong, R.E. "On an Analogy between the Conductivity for Heat and the Voltaic Induction-balance Effect of Copper-Tin Alloys," by W. Chandler Roberts, F.R.S.

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THE CHEMICAL NEWS.

Vol. XL. No. 1041.

A NEW PROCESS IN METALLURGY.*

By JOHN HOLLWAY.

The theory of this process has been developed from known principles, aided by experimental work undertaken for the purpose of investigating the action of rapid oxidation upon pyritous substances, with a view to their metallurgic treatment upon a large scale. Before these experiments were made metallurgists had not realised the fact that pyrites and other sulphides (even with the addition of a considerable proportion of incombustible materials) can be decomposed and fused by the heat developed in the oxidation which takes place whenever air is rapidly brought into contact with an excess of molten sulphides. When this is effected by introducing air under pressure through apertures of a few millimetres in diameter in the bottom of a hearth upon which the molten sulphides lie, the results produced are very remarkable. Thus, when cupreous pyrites was so treated, a true combustion of the more oxidisable constituents took place, flame and incandescence resulted, and the decomposition was effected with great rapidity.

It was primarily surmised that in this manner, neglecting the influence of mass, the elements would be burnt in the regular order of their relative affinities for oxygen, and that the second atom of sulphur in iron pyrites, which can be expelled by fusion, would escape oxidation in the molten bath and be volatilised in the current of sulphurous acid and nitrogen emerging from the surface of the molten liquid. The more volatile oxides and sulphides in the material operated upon, such as those of arsenic, antimony, lead, and zinc, would volatilise with this freed sulphur, and condense partly before it, though more or less contaminating that product. If the oxidation be arrested at a point determinable by practice, calculation, or some marked change in the spectrum, two products of different specific gravity will be obtained, namely, a slag of silicate of iron, lime, alumina, &c., containing the iron protoxide resulting from the oxidation of the iron sulphide, combined as silicate with the silicious fluxing materials present in the bath; and underneath this, the regulus or remaining unburnt sulphides, containing in an approximately known state of concentration the more valuable metals derived from the metalliferous substances operated upon. It was, however, necessary for the practical application of the theory that sufficient heat should be developed during the operation. The temperatures of combustion of various sulphides, calculated from known data, approached the maximum temperature attainable by the combustion of coal, and this inspired a considerable amount of confidence. In the case of iron pyrites these calculations are only rough approximations, as the latent heat of sulphur vapour is not known. It was found that when thus treating cupreous pyrites, the order in which the elements became oxidised was as follows:—

I.	II.	III.
Zinc and iron.	Sulphur.	Lead and copper.

The above reactions find a parallel in the elimination of the metalloids from cast-iron by Bessemer's process, in which silicon and carbon and then phosphorus and manganese are successively burnt out of the crude metal. Parallel analogies also exist between the processes of puddling and English copper smelting; where the oxidation proceeds but slowly, and the necessary heat is obtained by the burning of coal.

The foregoing conclusions have been verified experimentally; full particulars thereof will be found in papers brought before the Society of Arts, February 12 and April 30 of this year. Without recording the crucible experiments, I will proceed to describe briefly those made at Penistone and Sheffield. In the former place, ordinary Bessemer converters were used, as they were the only existing plant available, but it was from the first contemplated that a very different description of furnace would be requisite. The first of these experiments was made on the night July 10 of last year, at Messrs. Charles Cammell's Penistone Works. The pyrites employed contained about 2½ per cent copper, 1·5 ozs. silver, and approximately 3 grs. of gold per ton. About 6 tons of this mineral was melted in a cupola furnace, and the resulting proto-sulphides run into a converter. In this instance no silicious fluxes were added, the requisite silica being obtained from the gannister lining. The blast of air was at a pressure of from 15 to 20 lbs. The temperature gradually but steadily increased; a flame burnt continuously at the mouth of the vessel, where, after about twenty minutes' blow a pyrometer marked 1000° C., and wrought-iron melted in the incandescent sulphur vapour. The contents of the vessel were now very liquid, and at this period the protoxide of iron appears to have become converted into silicate as soon as it was formed. After thirty minutes' blow the silicious lining gave way at a weak place, cut through by the protoxide of iron, and a thin stream of very hot and liquid slag poured into the pit below. The converter was therefore emptied. The slag, consisting of ortho-silicate of iron, $2FeO,SiO_2$, crystallised on cooling in large and well defined crystals above a regulus of iron and copper, the line of demarcation between the two being very distinct. If the oxidation had been continued longer a yet higher temperature would have been obtained. On the succeeding night the experiment was repeated several times, but silicious material was thrown into the vessel during the operations, which greatly mitigated the corrosive action of the protoxide of iron on the silicious lining. On 17-18th July further experiments were made, and valuable data obtained. The pyrites used was the same as before. Red sand was thrown into the converters.

In experiments made at the commencement of November, 1878, the blow, after having been commenced with some molten proto-sulphide, was continued with the addition of 4 tons of cold pyrites in large lumps, together with 9 cwts. of moist sand. When the converter became too full of material, half the charge was tipped out, and the blow was continued with the addition of 18 cwts. of pyrites and 3 cwts. of sand. On the 5th of February last about 18 tons of raw pyrites, with sandstone, were treated continuously in this manner in one Bessemer, being converted into silicate of iron slag and a rich regulus at the rate of over 2 tons an hour. In all these experiments the blast entered cold and the gases escaped at a high temperature; sufficient quantities of silicious fluxes were not added, and the resulting dense slag occasionally entrapped considerable quantities of copper. But in specially constructed furnaces, where the heat produced is properly taken advantage of, and possibly augmented, much larger quantities of flux can be added, which will enable a slag to be produced containing less copper than is now found in the rejected slags of the Swansea process.

Further experiments were made at Messrs. John Brown and Co.'s Atlas Works, Sheffield. A rough plant was extemporised by connecting several ordinary cupolas, as shown in the diagram, one of which was provided with a Bessemer hearth. The sulphur and sublimates were condensed in the second and third cupolas. A large portion of the theoretical yield of sulphur was thus obtained, notwithstanding the imperfect appliances used. Slag and regulus were produced as before, and it was evident that the process could be carried on continuously. These ex-

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* Read before the British Association for the Advancement of Science (Section B.), Sheffield, 1879.

periments were not continued for any length of time, partly owing to the faulty construction of the forepart of the furnace, and partly to the irregular manner in which the materials were introduced.

The spectroscopic observations taken by Dr. W. M. Watts during the course of these experiments were valuable and interesting, and I am indebted to him for the following information:—

In the experiments at Penistone two spectra were observed; the first, that given by the flame from the charging-door of the cupola in which the pyrites was melted; the second, produced by the blast of air through the molten protosulphide in the converter. The cupola-spectrum was shown by direct comparison with the spectrum of a flame coloured by lead chlorate to be mainly due to oxide of lead, but contained besides some few of the lines which appear to be proper to the converter-spectrum. Analysis showed that the lead present in the ore was almost entirely volatilised during the preliminary melting of the ore, the molten protosulphide charged into the converter containing only 0·8 per cent lead. The converter flame gives a brilliant spectrum extending from the lithium line somewhat beyond the thallium line, which is usually present. Its most marked feature is the presence of four bright red lines about equally spaced between the sodium and lithium lines. Their wave-lengths, as far as at present known, are approximately 5999, 6151, 6320, and 6466, besides a fainter line at 6113. These lines are not those of any known spectrum. The way in which the flame is obtained suggests the theory that they are sulphur lines. When sulphur is burned in air or oxygen the spectrum obtained is entirely continuous, and even if air be bubbled through boiling sulphur no lines are obtained. Two spectra of sulphur obtained by the electric discharge through a vacuum tube containing vapour of sulphur have been described, but neither contains these four red lines. The spark with a Leyden jar in a current of sulphur dioxide at the ordinary pressure yields a spectrum (at present under investigation) apparently not previously described, in which, however, the red lines are altogether different from those of the converter-spectrum. The constancy with which these four red lines are associated together seems to preclude the possibility of their being due to different substances, otherwise the most refrangible line might be due to lead. No lines of copper were observed except in the fourth experiment, in which all the lines except those of sodium disappeared about six minutes before the turn down. When in this experiment, towards the end of the blow, the sub-sulphide of copper began to burn, a splendid emerald green flame suddenly appeared, and all the lines except those of copper and sodium left the spectrum. During the last few minutes of the blow the mouth of the converter was dull and without flame, the sulphur and oxidisable matter having been burnt out.

The pyrites, after fusion in the cupola at Penistone, gave protosulphides containing:—

	I.* Per cent.	II.* Per cent.
Iron	59·62	60·30
Copper	3·52	3·25
Zinc	1·52	1·88
Lead	0·79	0·81
Arsenic	0·06	0·05
Manganese	0·21	0·20
Alumina	0·15	trace
Lime	0·28	0·34
Magnesia	0 27	0·32
Sulphur	33·10	32·50
Silica	0·15	0·30
	99·67	99·95

The products consisted in the first place of a regulus, having a greater density than ordinary copper regulus on account of the larger proportion of iron, as compared with sulphur therein contained. The average specific gravity is 4·96. The following analyses illustrate the composition:—

	I.* Per cent.	II.* Per cent.	III.‡ Per cent.	V.‡ Per cent.	VI.† Per cent.
Iron	57·10	56·05	12·56	13·20	13·16
Copper	15·85	16·59	62·36	63·43	59·98
Zinc	0·84	0·48	0·42	Silver and Gold	0·152
Lead	0·22	0·31	0·14		
Arsenic	0·04	0 03	—	—	—
Manganese ..	0·22	0·20	—	—	—
Alumina.. ..	0·11	0·13	—	—	—
Lime	0·34	0·16	—	—	—
Magnesia ..	0·34	0·25	—	—	—
Sulphur	21·96	23·47	22·22	20·37	21·94
Silica or insoluble residue ..	2·00	1·10	0·28	1·20	2·57
Oxygen and not estimated ..	0·98	1·23	2·02	1·80	2·198
	100·00	100·00	100·00	100·00	100·000

	I.* oz. dwt. gr.	II.* oz. dwt. gr.	V.‡ oz. dwt. gr.	VI.† oz. dwt. gr.
Silver per ton of regulus	10 16 10	11 15 10	54 1 6	48 5 6
Gold ditto ..	0 6 12	0 7 0	1 1 5	1 4 11

The slag, the second product, when produced without the use of extraneous basic flux, is a black, lustrous, normal silicate of protoxide of iron, having the formula $2FeO,SiO_2$. Sulphur sometimes replaces part of the oxygen in it. Some specimens were very finely crystallised; the specific gravity is 4·05. This slag keeps very liquid at the temperature of the operation. The following represents the normal composition when using only sand as flux, and when no precautions are taken to obtain a complete separation of the regulus from the slag:—

	I.* Per cent.	II.* Per cent.	III.‡ Per cent.	V.† Per cent.	VI.‡ Per cent.
Iron protoxide	53·30	54·62	59·00	67·17	67·52
Iron peroxide..	3·00	3·71	—	—	—
Iron combined with sulphur	5·79	4·27	—	—	—
Copper ditto ..	0·16	0·22	1·55	0·87	0·42
Lead	0·12	0·10	—	—	—
Zinc oxide ..	1·15	1·75	0·98	—	—
Arsenic	trace	trace	none	—	—
Manganese oxide	0·32	0 37	0·30	—	—
Alumina	2·15	2·06	1·08	—	2·46
Lime	0·40	0·37	0·63	0·07	—
Magnesia ..	0·46	0·45	—	—	—
Sulphur	3·39	2·55	6·67	1·08	2·06
Silica	29·90	30·05	29·55	28·53	26·22
Oxygen and not estimated ..	—	—	0·24	2·28	1·32
	100·14	100·52	100·00	100·00	100·00

When, however, the products are overblown the protosilicate burns to silicate of peroxide of iron, a more infusible and less dense silicate, of which the following is an analysis:—

	IV.‡ Per cent.	
Silica	34·34	
Iron protoxide	25 10	=43·27 % Fe.
Iron peroxide..	33·83	
Manganese protoxide ..	0·12	
Alumina	1·81	
Zinc oxide	0·73	
Copper oxide	2·39	= 1·91 % Cu.
Lead oxide	0·03	
Lime	0·24	
Magnesia	0·30	
Sulphur	0·15	
Arsenic	none	
Phosphoric acid	0·031	
Not estimated and insoluble residue	1·45	
	100·521	

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* Analysed by Mr. J. E. Stead. † By Mr. E. Riley.
‡ By Mr. A. E. Arnold.

The third class of these products consists of metalliferous sublimates, and of sulphur. As an example of the former the following may be quoted:—

	Per cent.[*]	
Sulphate of lead	52·08	50·91 % Pb.
Sulphide	17·29	
Zinc oxide	21·78 =	17·47 ,, Zn.
Copper oxide	0·09 =	0·07 ,, Cu.
Iron sesquioxide	2·86	
Insoluble residue	2·14	
Not estimated and loss..	3·76	
	100·00	

The following is an analysis by Mr. J. S. Merry, of Swansea, of the crude sulphur dried at 100° C.:—

	Per cent.
Sulphur	63·30
Silica	7·00
Iron	2·76
Arsenic	7·12
Zinc	2·74
Lead	8·95
Copper	trace
Lime	trace
Magnesia	trace
Alumina..	trace
Oxygen (traces), carbon and loss ..	8·13
	100·00

The fourth, the gaseous product of the operation, consists mainly of sulphurous acid and nitrogen. The following are the analyses by Dr. Frankland, F.R.S.:—

	I. Per cent.	II. Per cent.
Nitrogen	86·00	88·37
Sulphurous acid	14·00	10·88
Oxygen..	—	0·75
	100·00	100·00

The principal cost of plant will be for the blast. I am indebted to Mr. W. H. Cutler, C.E., Queen Anne's Gate, Westminster, for the following information:—"The cost of a suitable pair of air pumps to pump 2000 tons of air per month of 28 days, working day and night, or 24,000 tons of air per annum, each pump capable on emergency of pumping the required quantity of air at 10 lbs. pressure on the square inch, viz., 30½ inches diameter with 5 feet stroke, on strong cast iron bed-plates, will cost £742 10s. The power required will be 100 horse-power. The dimensions and cost of the turbine must depend on the fall of water. For example, a fall of 72 cubic feet per second for 18 feet would drive a turbine 79 revolutions per minute, and produce 108 horse-power." The cost of one of Mr. Cutler's turbines, of suitable dimensions, would be £220. That of the furnace would not exceed £100, and say £200 for a culvert for collecting the sulphur and other sublimates. Twenty-four thousand tons of air would be more than sufficient to supply the necessary oxygen to 15,000 ton of pyrites, since 1·4 part by weight of air will convert one part of ordinary cupreous pyrites into rich regulus. It therefore appears from the foregoing figures that where sufficient water power is available a plant capable of treating 15,000 tons of pyrites annually could be erected at a cost of about £1500. Where, however, water power is not available steam boilers will be requisite, and the additional cost for plant may be £500 or perhaps £1000. Messrs. Howson and Wilson estimate that compound engines of 2400 horse-power, with 23 boilers of ordinary size heated by 20,000 tons of coal, would be sufficient to supply 480,000 tons of air annually at a pressure of 17 pounds per square inch. This quantitiy is more than sufficient to supply the necessary oxygen to 300,000 tons of pyrites. The same gentlemen estimate that the consumption of coal requsite to heat the blast to 1000° F. would be about 11,000 tons per annum, but this quantity will be materially decreased if the heat from the exit gases be utilised.

With regard to the furnace it is proposed to make the hearth, or rather crucible, of silicious, aluminous, or refractory carbonaceous material. A sufficiently large proportion of silicious flux in the furnace charge will greatly mitigate the action of the resulting iron protoxide upon the silica of the lining. Aluminous shrunk bricks may answer still better. It might even be found convenient to allow considerable corrosion to the lining to take place, if the converting hearth is of such form, and the materials are of such a nature, that it can be readily and economically renewed.

It may be also advantageous to run the regulus and slag, after the desired concentration has been effected, directly on to the hearth of a reverberatory furnace, where they can be kept molten by external heat, and where a more perfect separation of the one from the other may be effected. In such a furnace the final oxidation of the rich regulus would probably be most conveniently effected, although it is of course possible to produce metallic copper from the regulus by the transmission of air currents in a specially constructed furnace.

Not only would antimony, lead, zinc, copper, nickel, silver, and other valuable metals be extracted from the sulphides that contain them, but also from the incombustible fluxing materials that are added to the charge, and the extraction of the copper, and silver and gold will probably be more complete, than by any known process. In countries where cupreous silicious schists and sandstones abound, the use of these as silicious fluxes would partially, if not wholly, compensate for the loss of copper in the slag. Thus, by using 0·5 ton of such material, containing 0·5 per cent of copper for each ton of the sulphuretted ore, the whole of the copper could be recovered from the latter, assuming the slag to contain even as much as 0·2 per cent of that metal.

The crude sulphur may be freed from the accompanying sulphide of arsenic by boiling it with milk of lime, and from the metallic oxides and sulphides with which it is contaminated by distillation; or purification by bisulphide of carbon might be resorted to. The sulphurous acid can be oxidised in chambers to sulphuric acid, either with or without previous liquefaction.

This process, on account of its simplicity and economy, may reasonably be expected, not only to take the place of the ordinary smelting, but also of many of the wet processes now in use.

Examination and Estimation of Manurial Matters especially Bone Dust.—Prof. Krocker.—Ground bones have often been previously completely exhausted of gelatin and horn dust, leather waste, &c., are afterwards added to make up the guaranteed proportion of nitrogen. Good ground bones should contain to 20 to 22 per cent of phosphoric acid at least 3 to 3½ per cent of nitrogen due to gelatin, to which even in the best samples horn dust is added so as to bring up the total nitrogen to 3·5 to 4 per cent. To ascertain the presence of such additions the author shakes up bone meal with chloroform, when horn, blood, leather waste, &c., rise to the surface, whilst bone earth mixed with its natural gelatigenous matter, and pure phosphates remain at the bottom. So-called vegetable ivory remains also at the bottom, and must be recognised microscopically. Horn dust as met with in commerce contains about 15 per cent of nitrogen.—*Biedermann's Central-blatt für Agrikultur Chemie.*

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[*] Analysed by Mr. A. E. Arnold.

ON THE VAPOUR-DENSITIES OF PEROXIDE OF NITROGEN, FORMIC ACID, ACETIC ACID, AND PERCHLORIDE OF PHOSPHORUS.

By J. WILLARD GIBBS.

THE relation between temperature, pressure, and volume, for the vapour of each of these substances differs widely from that expressed by the usual laws for the gaseous state—the laws known most widely by the names of Mariotte, Gay-Lussac, and Avogadro. The *density* of each vapour, in the sense in which the term is usually employed in chemical treatises, *i.e.*, its density taken relatively to air of the same temperature and pressure,[*] has not a constant value, but varies nearly in the ratio of one to two. And these variations are exhibited at pressures not exceeding that of the atmosphere and at temperatures comprised between zero and 200° or 300 °of the centigrade scale.

Such anomalies have been explained by the supposition that the vapour consists of a mixture of two or three different kinds of gas or vapour, which have different densities. Thus, it is supposed that the vapour of peroxide of nitrogen is a gas-mixture, the components of which are represented (in the newer chemical notation) by NO_2 and N_2O_4 respectively. The densities corresponding to these formulæ are 1·589 and 3·178. The density of the mixture should have a value intermediate between these numbers, which is substantially the case with the actual vapour. The case is similar with respect to the vapour of formic acid, which we may regard as a mixture of CH_2O_2 (density 1·589) and $C_2H_4O_4$ (density 3·178), and the vapour of acetic acid, which we may regard as a mixture of $C_2H_4O_2$ (density 2·073) and $C_4H_8O_4$ (density 4·146). In the case of perchloride of phosphorus, we must suppose the vapour to consist of three parts:—PCl_5 (the proper perchloride, density 7·20), PCl_3 (the protochloride, density 4·98), and Cl_2 (chlorine, density 2·22). Since the chlorine and protochloride arise from the decomposition of the perchloride, there must be as many molecules of the type Cl_2 as of the type PCl_3. Now a gas mixture containing an equal number of molecules of PCl_3 and Cl_2 will have the density $\frac{1}{2}(4·98+2·22)$ or 3·60. It follows that, at least so far as the range of the possible values of its density is concerned, we may regard the vapour as a mixture in variable proportions of two kinds of gas having the densities 7·20 and 3·60 respectively. The observed values of the densities accord with this supposition.

These hypotheses respecting the constitution of the vapours are corroborated, in the case of peroxide of nitrogen and perchloride of phosphorus, by other circumstances. The varying colour of the first vapour may be accounted for by supposing that the molecules of the type N_2O_4 are colourless, while each molecule of the type NO_2 has a constant colour. This supposition affords a simple relation between the density of the vapour and the depth of its colour, which has been verified by experiment.[†]

The vapour of the perchloride of phosphorus shows with increasing temperature in an increasing degree the characteristic colour of chlorine. The amount of the colour appears to be such as is required by the hypothesis respecting the constitution of the vapour on the very probable supposition that the perchloride proper is colourless, but the case hardly admits of such exact numerical determinations as are possible with respect to the peroxide of nitrogen.[‡] But since the products of dissociation are in this case dissimilar, they may be partially separated by diffusion through a neutral gas, the lighter chlorine diffusing more rapidly than the heavier protochloride. The fact of dissociation has in this way been proved by direct experiment.[*]

In the case of acetic and formic acids, we have no other evidence than the variations of the densities in support of the hypothesis of the compound nature of the vapour, yet if these variations shall appear to follow the same law as those of the peroxide of nitrogen and the perchloride of phosphorus, it will be difficult to refer them to a different cause.

But however it may be with these acids, the peroxide of nitrogen and the perchloride of phosphorus evidently furnish us with the means of studying the laws of chemical equilibrium in gas mixtures in which chemical change is possible and does in fact take place, reversibly, with varying conditions of temperature and pressure. Or, if from any considerations we can deduce a general law determining the proportions of the component gases necessary for the equilibrium of such a mixture under any given conditions, these substances afford an appropriate test for such a law.

In a former paper[†] by the present writer equations were proposed to express the relation between the temperature, the pressure, or the volume, and the quantities of the components in such a gas mixture as we are considering —*a gas mixture of convertible components* in the language of that paper. Applied to the vapour of the peroxide of nitrogen, these equations led to a formula giving the density in terms of the temperature and pressure, which was shown to agree very closely with the experiments of Deville and Troost, and much less closely, but apparently within the limits of possible error, with the experiments of Playfair and Wanklyn. Since the publication of that paper, new determinations of the density have been published in different quarters, which render it possible to compare the equation with the results of experiment throughout a wider range of temperature and pressure. In the present paper all experimental determinations of the density of this vapour which have come to the knowledge of the writer are cited, and compared with the values demanded by the formula, and a similar comparison of theory and experiment is made with respect to each of the other substances which have been mentioned.

The considerations from which these formulæ were deduced may be briefly stated as follows. It will be observed that they are based rather upon an extension of generally acknowledged principles to a new class of cases than upon the introduction of any new principle.

The energy of a gas mixture may be represented by an expression of the form—

$$m_1(c_1t+E_1)+m_2(c_2t+E_2)+\text{ \&c.},$$

with as many terms as there are different kinds of gas in the mixture, m_1, m_2, &c., denoting the quantities (by weight) of the several component gases, c_1, c_2, &c., their several specific heats at constant volume, E_1, E_2, &c., other constants, and t the absolute temperature. In like manner the entropy of the gas mixture is expressed by—

$$m_1\left(H_1+c_1\log_N t-a_1\log_N\frac{m_1}{v}\right)$$
$$+m_2\left(H_2+c_2\log_N t-a_2\log_N\frac{m_2}{v}\right)+\text{\&c.}$$

Where x denotes the volume, and H_1, a_1, H_2, a_2, &c., denote constants relating to the component gases, a_1, a_2, &c., being inversely proportional to their several densities. The logarithms are Naperian. These expressions for energy and entropy will undoubtedly apply to mixtures of

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[*] The language of this paper will be conformed to this usage.

[†] Salet, "Sur la Coloration du Peroxyde d'azote." *Comptes Rendus*, t. lxvii., p. 488.

[‡] H. Sainte-Claire Deville, "Sur les Densités de Vapeur." *Comptes Rendus*, t. lxii., p. 1157.

[*] Wanklyn and Robinson, "On Diffusion of Vapours: a means of distinguishing between apparent and real Vapour-densities of Chemical Compounds." *Proc. Roy. Soc.*, vol. xii., p. 507.

[†] "On the Equilibrium of Heterogeneous Substances." *Transactions of the Connecticut Academy*, vol. iii., p. 108. The equations referred to are (313), (317), (319). and (320) on pages 233 and 234. The applicability of these equations to such cases as we are now considering is dicussed under the heading "Gas-mixtures with Convertible Components," page 234.

different gases, whatever their chemical relations may be (with such limitations and with such a degree of approximation as belong to other laws of the gaseous state), when no chemical action can take place under the conditions considered. If we assume that they will apply to such cases as we are now considering, although chemical action is possible, and suppose the equilibrium of the mixture with respect to chemical change to be determined by the condition that its entropy has the greatest value consistent with its energy and its volume, we may easily obtain an equation between m_1, m_2, &c., t and v.*

The condition that the energy does not vary gives—

$$(m_1c_1+m_2c_2+\&c.)dt+(c_1t+E_1)dm_1 \\ +(c_2t+E_2)dm_2+\&c.=0. \qquad (1)$$

The condition that the entropy is a maximum implies that its variation vanishes when the energy and volume are constant: this gives—

$$\frac{m_1c_1+m_2c_2+\&c.}{t}dt+\left(H_1-a_1+c_1\log_N t-a_1\log_N\frac{m_1}{v}\right)dm_1 \\ +\left(H_2-a_2+c_2\log_N t-a_2\log_N\frac{m_2}{v}\right)dm_2+\&c.=0. \qquad (2)$$

Eliminating dt, we have—

$$\left(H_1-a_1-c_1-\frac{E_1}{t}+c_1\log_N t-a_1\log_N\frac{m_1}{v}\right)dm_1 \\ +\left(H_2-a_2-c_2-\frac{E_2}{t}+c_2\log_N t-a_2\log_N\frac{m_2}{v}\right)dm_2+ \\ +\&c.=0. \qquad (3)$$

If the case is like that of the peroxide of nitrogen this equation will have two terms, of which the second may refer to the denser component of the gas mixture. We shall then have $a_1=2a_2$, and $dm_1=-dm_2$, and the equation will reduce to the form—

$$\log.\frac{m_2v}{m_1^2}=-A-B\log.t+\frac{C}{t}, \qquad (4)$$

where common logarithms have been substituted for Naperian, and A, B, and C are constants. If, in place of the quantities of the components, we introduce the partial pressures, p_1, p_2, due to these components, and measured in millimetres of mercury, by means of the relations—

$$m_1=\frac{p_1v}{a_1t}, \qquad m_2=\frac{p_2v}{\tfrac{1}{2}a_1t},$$

where a_1 denotes a constant, we have—

$$\log\frac{p_2}{p_1^2}=-(A+\log 2a_1)-(1+B)\log t+\frac{C}{t} \\ =-A'-B'\log t+\frac{C}{t}, \qquad (5)$$

where A′ and B′ are new constants. Now if we denote by p the total pressure of the gas mixture (in millimetres of mercury) by D, its density relative to air of the same temperature and pressure), and by D_1, the theoretical density of the rarer component, we shall have—

$$p:p+p_2::D_1:D.$$

This appears from the consideration that $p+p_2$ represents what the pressure would become if, without change of temperature or volume, all the matter in the gas mixture could take the form of the rarer component. Hence—

$$p_2=p\frac{D-D_1}{D_1},$$

$$p_1=p-p_2=p\frac{2D_1-D}{D_1},$$

and—

$$\frac{p_2}{p_1^2}=\frac{D_1(D-D_1)}{p(2D_1-D)^2},$$

By substitution in (5) we obtain—

$$\log\frac{D_1(D-D_1)}{(2D_1-D)^2}=-A'-B'\log t+\frac{C}{t}+\log p_1. \qquad (6)$$

By this formula, when the values of the constants are determined, we may calculate the density of the gas mixture from its temperature and pressure. The value of D_1 may be obtained from the molecular formula of the rarer component. If we compare equations (3), (4), and (5) we see that—

$$B'=B+1, \qquad B=\frac{c_1-c_2}{a_2}.$$

Now c_1-c_2 is the difference of the specific heats at constant volume of NO_2 and N_2O_4. The general rule that the specific heat of a gas at constant volume and per unit of weight is independent of its *condensation* would make $c_1=c_2$, $B=0$, and $B'=1$. It may easily be shown, with respect to any of the substances considered in this paper,* that unless the numerical value of B′ greatly exceeds unity, the term B′ log t may be neglected without serious error, if its omission is compensated in the values given to A′ and C. We may therefore cancel this term, and then determine the remaining constants by comparison of the formula with the results of experiment.

In the case of a mixture of Cl_2, PCl_3, and PCl_5, equation (3) will have three terms distinguished by different suffixes. To fix our ideas, we may make these suffixes 2, 3, and 5, referring to Cl_2, PCl_3, and PCl_5 respectively. Since the constants a_2, a_3, and a_5 are inversely proportional to the densities of these gases—

$$a_2dm_2=a_3dm_3=-a_5dm_5,$$

and we may substitute—

$$\frac{1}{a_2}, \qquad \frac{1}{a_3}, \qquad \frac{-1}{a_5}$$

for dm_2, dm_3, and dm_5 in equation (3), which is thus reduced to the form—

$$\log\frac{m_5v}{m_2m_3}=-A-B\log t+\frac{C}{t}. \qquad (7)$$

If we eliminate m_2, m_3, m_5 by means of the partial pressures, p_2, p_3, p_5, we obtain—

$$\log\frac{p_5}{4p_2p_3}=-A'-B'\log t+\frac{C}{t} \qquad (8)$$

when A′, B′, like A, B, and C, are constants. If the chlorine and the protochloride are in such proportions as arise from the decomposition of the perchloride, $p_2=p_3$ and $4p_2p_3=(p_2+3)^2$. In this case, therefore, we have—

$$\log\frac{p_5}{(p_2+p_3)^2}=-A'-B'\log t+\frac{C}{t}. \qquad (9)$$

It will be seen that this equation is of the same form as equation (5), when p_5 in (9) is regarded as corresponding to p_2 in (5), and p_2+p_3 in (9), which represent the pressure due to the products of decomposition, is regarded as corresponding to p_1 in (5), which has the same signification. It follows that equation (5), as well as (6), which is derived from it, may be regarded as applying to the vapour of perchloride of phosphorus, when the values of the constants are properly determined. This result might have been anticipated, but the longer course which we have taken has given us the more general equations, (7) and (8), which will apply to cases in which there is an excess of chlorine or of the protocloride.

If the gas mixture considered, in addition to the components capable of chemical action, contains a neutral gas, the expression for the energy and entropy of the gas mixture should properly each contain a term relating to this neutral gas. This would make it necessary to add c_nm_n to the coefficient of dt in (1), and $\frac{c_nm_n}{t}$ to the coefficient of

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* For certain *a priori* considerations which give a degree of probability to these assumptions, the reader is referred to the paper already cited.

* For the case of peroxide of nitrogen see pp. 243, 244 in the pape cited above.

TABLE I.—PEROXIDE OF NITROGEN.

Experiments at Atmospheric Pressure.

Mitscherlich—R. Müller—Deville and Troost.

Temperature.	Pressure.	Density calc. by eq. (10).	Density Observed.				Excess of Observed Density.			
			M—h. M—r.	Deville and Troost. I.	II.	III.	M—h. M—r.	Deville and Tooost. I.	II.	III.
183·2	(760)	1·592				1·57				−0·022
154·0	(760)	1·597				1·58				−0·017
151·8	(760)	1·598		1·50				−0·10		
135·0	(760)	1·607				1·60				−0·007
121·8	(760)	1·622		1·64				+0·02		
121·5	(760)	1·622				1·62				−0·002
111·3	(760)	1·641				1·65				+0·009
100·25	760	1·677	1·72				+0·04			
100·1	(760)	1 676				1·68				+0·004
100·0	(760)	1·677		1·71				+0·03		
90·0	(760)	1·728				1·72				−0·008
84·4	(760)	1·768		1·83				+0·06		
80·6	(760)	1·801				1·80				−0·001
79	748	1·814	1·84				+0·03			
77·4	(760)	1·833			1·85				+0·02	
70·0	(760)	1·920				1·92				0·000
70	754·5	1·919	1·95				+0·03			
68·8	(760)	1·937		1·99				+6·05		
66·0	(760)	1·976			2·03				+0·05	
60·2	(760)	2·067				2·08				+0·013
55·0	(760)	2·157			2·20				+0·04	
52	757	2·211	2·26				+0·05			
49·7	(760)	2·255		2·34				+0·09		
49·6	(760)	2·256				2·27				+0·014
45·1	(760)	2·342			2·40				+0·06	
39·8	(760)	2·443				2·46				+0·017
35·4	(760)	2·524				2·53				+0·006
35·2	(760)	2·528		2·66				+0·13		
34 6	(760)	2·539			2·62				+0·08	
32	748	2·582	2·65				+0·07			
28·7	(760)	2·642		2 80				+0·16		
28	751	2·652	2·70				+0·05			
27·6	(760)	2·661			2·70				+0·04	
26·7	(760)	2·676				2·65				−0·026

dt in (2), the suffix $_n$ being used to mark the quantities relating to the neutral gas. But these quantities would disappear with the elimination of *dt*, and equation (3) and all the subsequent equations would require no modification if only p and D are estimated (in accordance with usage) with exclusion of the pressure and weight due to the neutral gas. This result, which may be extended to any number of neutral gases, is simply an expression of Dalton's law.

We now proceed to the comparison of the formulæ, especially of equation (6), with the results of experiment.

(To be continued.)

ON ERBIA.

By P. T. CLEVE.

At the meeting of the Academy on September 15, M Soret made some remarks on a memoir which I presented to the Academy on the 1st September, in which I stated that from an examination of the absorption spectra old erbia is capable of being divided into three different bodies. When I made the researches described in that memoir I was not aware of the work of M. Soret. From his remarks, however, it is evident that he had previously discovered the same facts. He consequently has the priority, and I am glad to have the opportunity of doing him justice.

The body for which I proposed the name of *holmium* is evidently the same that M. Soret calls X. I have not been able to identify it with the philippium of M. Delafontaine, because that body is characterised by an absorption ray in the blue part of the spectrum, which ray occupies the same place as a ray of erbia. Besides, the body X possesses rather a high atomic weight, whilst that of philippia is pointed out as being very low. Anyhow, it has been proved, as a certain fact, that the rays λ=640 and λ=536 do not belong to erbia, as I have succeeded in almost entirely eliminating them from the spectrum of erbia. As to the body which I have called *thulium*, it is evident that M. Soret was again before me in observing the variations in intensity of its absorption ray. I think I have unmistakably proved that this ray does not belong to erbia, because I obtained a fraction of erbia whose spectrum did not contain that ray, and gave only traces of the rays of the body X. If this ray belongs neither to ytterbia nor to erbia, it seems to me that it must be due to some elements at present unknown. I am now engaged in procuring new materials for the preparation of these rare bodies, which are so difficult to separate. Very recently I began an experiment with 11 kilos. of gadolinite, the treatment of which is already so far advanced that it is to be hoped that the questions as to the yttria earths will soon receive their solution.—*Comptes Rendus*, October 27.

The Royal Polytechnic.—The Directors of this Institution are increasing the number of special daily entertainments. The more scientific portion of the new programme includes a description and exhibition of Edison's loud-speaking telephone which in itself forms a great attraction. There are also lectures on Chemistry of Coal and on Flashing Signals. A practical demonstration of Fleuss's system of Walking Under Water is also given by the inventor.

COMPOSITION AND QUALITY OF THE METROPOLITAN WATER.

OCTOBER, 1879.

THE following are the returns of the Society of Medical Officers of Health:—

	Appearance in 2 foot Tube.	Ammonia.		Nitrogen as Nitrates, &c.	Oxygen used to Oxidise Organic Matter.	Total Solids.	Lime.	Magnesia	Chlorine	Sulphuric Anhydride.	Hardness on Clark's Scale	
		Saline.	Organic.								Before Boiling.	After Boiling.
		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Degrees	
Thames Water Companies.												
Grand Junction	Clear	0·000	0·008	0·135	0·103	21·40	7·340	0·360	1·080	1·070	13·7	4·6
West Middlesex	Clear	0·000	0·010	0·129	0·111	21·40	7·700	0·396	1·150	1·360	13·7	4·2
Southwark and Vauxhall	Clear	0·000	0·008	0·117	0·088	21·60	7·280	0·468	1·150	1·300	13·2	4·2
Chelsea	Clear	0·000	0·008	0·138	0·085	21·00	7·750	0·371	1·220	1·300	13·7	4·6
Lambeth	Clear	0·000	0·009	0·148	0·092	21·10	7·530	0·428	1·220	1·300	14·8	3·3
Other Companies.												
Kent	Clear	0·000	0·005	0·480	0·022	29·46	10·700	0·396	1·870	2·600	19·4	6·5
New River	Clear	0·000	0·006	0·126	0·052	21·00	7·630	0·468	1·150	1·200	13·7	3·3
East London	Clear	0·000	0·008	0·144	0·086	20·00	7·950	0·432	1·220	1·200	14·3	4·2

The quantities of the several constituents are stated in grains per imperial gallon.

NOTE.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

C. MEYMOTT TIDY, M.B.

ON THE
ESTIMATION OF CARBON IN CAST-STEELS.

By SERGIUS KERN, M.E., St. Petersburg.

THIS summer the author analysed several samples of crucible steel for carbon. In most of the laboratories of steel works Eggertz's method is used for that purpose. But as it was desired to estimate the contents of the carbon in the steels in hand as accurate as possible, the ordinary combustion method was adopted. Chromic acid was used. Meanwhile, all the samples were also tested by the Eggertz's process. The results of the analyses differ very much if steel is analysed by both methods. The following table gives the percentage of carbon found in the steels:—

Eggertz's Method.	Combustion Method.
0·12	0·14
0·15	0·17
0·24	0·27
0·34	0·38
0·36	0·37
0·45	0·46
0·60	0·64
1·03	1·02

In laboratories Eggertz's process may only be used for rough estimations, but it must be regretted that, at the present time, this rule is nearly abandoned.

CORRESPONDENCE.

EMPLECTITE.

To the Editor of the Chemical News.

SIR,—Having lately discovered at the Aamdal Copper Mines, Upper Thelemarken, Norway, the mineral emplectite, and observing that Dana in his system of mineralogy, does not mention any localities in Norway for this mineral, I gladly hand you this notice of its discovery here for your valuable journal.

The mineral, on analysis, gave,—

Bismuth	57·72
Copper	17·23
Silver	2·91
Lead	a trace
Sulphur	19·20
Silica	1·30
	98·36

The silver here without doubt replacing a part of the bismuth or copper, allowing the composition of this mineral to be of the formula $CuS+Bi_2S_3$.—I am, &c.,—

F. R. W. DAW.

Aamdals Kobberværk, Skafse,
Ovre Thelemarken,
October 25, 1879.

THE DISSOCIATION OF CHLORINE.

To the Editor of the Chemical News.

SIR,—If Mr. F. P. Dunnington had not the impression that $PtCl_4$ (platinic chloride) was the source of the chlorine with which Victor Meyer performed his experiments, why base suppositions or suggestions of error upon reactions of a compound which was not used? The residue Mr. Dunnington obtained on heating this, consisting, as he says, "*of* $PtCl_2$, *with but little* Pt *and* $PtCl_4$," is the real substance in question; and as nothing is said of oxygen compounds in this, Mr. Dunnington had surely nothing on which to base the question of "due care having been taken," from his own experiments, as recorded in the communication cited (CHEMICAL NEWS, vol. xl., p. 141). I stated in my letter appearing in CHEMICAL NEWS (vol. xl., p. 155) that "*extraordinary care*" had been taken by Prof. V. Meyer to make sure he was working with the pure platinous chloride (Pt_2Cl_4 or $PtCl_2$), and to prove that I made no unfounded statement I will quote the analyses he gives in the *Deut. Chem. Ges. Ber.* for July (xii., p. 1429). He says there "The platinous chloride used by us consisted of a dark olive-green powder, giving on analysis:—

(1.) 0·2247 grm. substance gave 0·1654 grm. Pt.
(2.) 0·3318 ,, ,, ,, 0·2436 ,, ,,
(3.) 0·2612 ,, ,, ,, 0·1918 ,, ,,
(4.) 0·2122 ,, required of $\frac{1}{10}$ normal hyposulphite : 15·8 c.c.
(5.) 0·2802 ,, ,, ,, ,, 20·7 c.c.

	Found.	Calculated. Per cent.
Whence Pt =	73·61, 73·39, 73·43	73·54
Cl =	26·35, 26·15	26·46
		100·00

I would strongly recommend Mr. Dunnington to read the paper referred to in the *Berliner Berichte*, and he will see that Victor Meyer's work is simply a model of scientific care and accuracy. He will find nothing there about oxygen having been obtained, because V. Meyer's critical investigations on this point were then still proceeding, and I believe are still.—I am, &c.,

WATSON SMITH, F.C.S., F.I.C.

The Owens College, Manchester,
October 31, 1879.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Biedermann's Central-blatt für Agrikultur-Chemie.
October, 1879.

Experiments on the Culture of Different Vegetables.—F. Blick.

Digestion of Meadow Fodder in Different Stages of its Growth by Horses and Sheep.—Prof. E. v. Wolff and others.—These two papers are not capable of useful abstraction.

Quantity of Respiration in Swamp and Water Plants.—E. Freyberg.—The roots of such plants, in equal units of time and in proportion to their mass or dry substance, consume less oxygen than the roots of land plants. A land plant can the more easily adapt itself by natural selection to swamp life the less albuminoid matter it contains, and the lower consequently its nutritive value.

Influence of Nutrition on the Perspiration of Plants. —Prof. A. Burgerstein.

Migration of Nitrogen and of the Mineral Constituents of a Maple during the First Development of the Shoots in Spring.—Dr. Julius Schrœder.—The botanical name of the species in question is omitted.

Inorganic Constituents of the Pine and the Birch. —Dr. Julius Schrœder.

The Colouring Matters of Grape Skins, and a New Method of Recognising the Full Ripeness of Grapes. —Prof. E. Pollacci.—When grapes are fully ripe the green colouring-matter of their skins disappears.

Development of Oats.—P. Dehérain and Nantier.

Jelly of Beet-root.—Prof. L. Cienkowski.

Manoury's Process of Removing Sugar from Treacle.—No author's name is attached to this paper.

Analysis of Crude Sugar.—E. Laugier.—Taken from the *Comptes Rendus*.

Abnormal Composition of Human Milk.—C. Marchand.—If the fatty matter exceeds 52 parts per 1000 the milk becomes injurious. A similar result is experienced if the protein compounds greatly exceed the normal proportion of 17 per 1000. An increase of milk-sugar is not hurtful.

Determination of Fat in Milk by means of the Lacto-butyrometer.—F. Schmidt, Dr. v. Grote, C. Marchand, and others.—MM. Schmidt and Tollens omit the addition of soda-lye which Marchand recommends; they use alcohol at 91 instead of 86 per cent; they measure the liquids with pipettes; after heating to 40° they place the lacto-butyrometer in water of 20°, and they use different formulæ for calculation.

Milk Centrifugals.—Dr. Engling and others.

Milk Coolers of Lawrence, Rössler, and Neubecker. —Prof. Wüst.

Milk and Milk Inspection.—Prof. Schulze, Dr. Frühling, and Dr. J. Schulze.—An account of a controversy on the standards for genuine milk.

Journal für Praktische Chemie.
Nos. 15 to 18, 1879.

The Doctrine of Chemical Valence, and its Relation to the Electro-Chemical Theory.—Al. Rau.—In this paper, to which it is not possible to do justice in the compass of an abstract, the author seeks to show that electro-chemical conceptions may still be the guides of our theoretical considerations. They are particularly useful as setting wholesome limits to our imagination, and are calculated to banish from the science the empty playing with formulæ.

On Sulphanilic Acid.—Dr. C. Laar.—The author describes the free acid, its salts, its behaviour with the pentachloride of phosphorus, and the formation of the phosphanilid-sulphon compounds, and the oxidation of sulphanilic acid by potassium permanganate.

Oxyphenyl Acetic Acid and its Derivatives.—Dr. P. Fritzsche.—After a very elaborate description of this acid and its derivatives, the author concludes that it is not to be regarded as a true ether-acid, but still retains the properties of phenol.

Influence of Melting Alkalies upon certain Aromatic Sulphonic Acids.—Dr. P. Degener.—Among the compounds thus treated are phenol-ortho-sulphonic acid, phenol-para-sulphonic acid, and benzol-disulphonic acid. The actions of potassa and soda are by no means identical. In an appendix the author gives methods for the determination of pyrocatechin, for the indirect determination of a mixture of alkaline benzol-disulphonate and meta-phenol-sulphonate, and for the volumetric determination of resorcin by means of bromine water and chloride of lime.

Desulphurisation of Rhodan-guanidin—Dr. S. Byk. —The author has not succeeded in desulphurising rhodanguanidin in alcoholic or aqueous solution, either by mercury or lead-oxide.

On Ethylen-chlor-sulphocyanide and β-Chlor-ethylsulphonic Acid.—J. William James.—By the action of equal molecules of potassium sulphocyanide, and ethylenchlor-bromide the bromine is eliminated, and its place is supplied by sulphocyanogen, the result being ethylenchlor-sulphocyanide.

Chemical Investigation of the Ferdinand-Spring at Marienbad, in Bohemia.—Dr. W. F. Gintl.

Compounds of Lithium Chloride and Magnesium Chloride with Alcohols.—S. E. Simon.—The author has obtained and examined the alcoholates and methylates of the two chlorides.

Electrolytic Experiments.—E. Drechsel.—The author, setting out from the observation that certain chemical transformations observed in the living organism do not depend solely upon oxidation or reduction, but upon both, has endeavoured to find out a method which should permit to carry on in the same liquid both these processes in rapid succession.

Derivatives of Propionic Acid.—B. Freytag.—A preliminary communication.

Action of Sulphuryl Chloride upon Alcohols.—Dr. P. Behrend.—A reply to P. Claesson.

Dingler's Polyteehnisches Journal.
October, 1879.

Chemical Stability of Explosives.—F. Hess.—For practical purposes it is generally sufficient to expose small quantities of the material for eight days in an air-tight vessel to a temperature of 70°. If neither explosion nor the appearance of decomposition products, *e.g.*, hyponitric acid, the substance may be regarded as stable. If the explosive requires to be preserved for years, a more rigorous test is required, which cannot be made intelligible without the accompanying figure.

Apparatus for the production of High Temperatures.—C. A. Paguelin.—Mixtures of combustible gases or vapours with common air are burnt in an especially-constructed receptacle.

Apparatus for determining Solubilities.—H. Kœhler.—Requires the appended figure.

Determination of Iodine in Sea-weeds.—O. Schott.—From the *Zeitschrift f. Anal. Chemie*, 1879, p. 443.—Requires figure.

Examination of Atmospheric Air.—F. Fischer.

Examination and Treatment of Petroleum.—H. Hörler.

Development of Dyeing, Tissue-printing, and Bleaching.—Dr. A. Kielmeyer.—These three papers do not admit of useful abstraction.

Determination of Potassa and Soda in Minerals.—W. Knop and J. Hazard.—The authors dissolve in hydrofluoric acid, evaporate, drench the residue with concentrated sulphuric acid, thus removing the bulk of the silica as silicon fluoride. The sulphuric acid is then evaporated off, the dry residue moistened with five or six drops of concentrated sulphuric acid, heated, drenched with 150 c.c. water, and barium hydrate added till red litmus-paper is turned distinctly blue. The mixture of barium sulphate, silica, alumina, magnesia, and ferric oxide is then filtered off and well washed. The filtrate is evaporated to dryness, adding, when it is concentrated down to about 200 c.c., a few grammes of dry ammonium sesquicarbonate. When perfectly dry the residue of barium and calcium carbonate is extracted successively fifteen times, each time with 20 c.c. water, the liquid being each time filtered through a small filter of 3 to 4 c.m. diameter into a platinum capsule, and evaporated to dryness. The residue is drenched again with 20 c.c. water, the water is decanted through a similar fresh filter, and the solution—after it has deposited a little barium carbonate with some alumina and iron—is collected along with the washings in a fresh platinum capsule. The alkaline carbonate, to which a few more granules of ammonium carbonate have been added, is again dissolved in 20 c.c. water, observing that no residue remains. The liquid is then neutralised with hydrochloric acid, evaporated, the chlorides dried strongly, and the potassium and sodium separated by means uf platinum chloride.—*Chem. Central Blatt.*

Moniteur Scientifique, Quesneville.
November, 1879.

On Nitrification.—R. Warington.—From the *Journal of the Chemical Society*.

Manufacture of Carbonate of Potash by Leblanc's Process.—Dr. A. Blugel.—The conditions of this manufacture differ from those of the manufacture of soda, on account of the higher price of the raw material, the greater volatility of potassium compounds at high temperatures, the slight solubility of potassium sulphate concentrated solutions of potassium carbonate, and the non-formation of mother-liquors in the course of the manufacture. It is remarked that if a certain English coal, known as "Ryhope peas," be employed, ferro-cyanide is obtainable up to 1 per cent.

Preparation of Nitro-glycerin.—H. Boutmy.—Not capable of useful abstraction.

On Aurin.—R. S. Dale and C. Schorlemmer.—From the *Journal of the Chemical Society.*

The Phosphates of Lime of Quercy.—M. Rey-Lescure.—An account of the geological position of these deposits, the accompanying fossils, &c.

Origin of Phosphorus in its Various Deposits, and in particular in those of Quercy.—M. Daubrée.—The author holds that phosphorus, notwithstanding its association with fossil bones, is of profound and inorganic origin, its chief source being the eruptive rocks. Meteorites also supply proof of the general distribntion of phosphorus in the celestial spaces.

Researches on Amblygonite, and the means of its Utilisation in Agriculture.—M. le Baron P. Thenard.—The substance operated upon contained—

Phosphoric acid	39·00
Alumina	25·66
Ferric oxide	1·71
Lime	1·10
Insoluble matter	10·55
Lithia, potassa, soda, &c.	21·98
	100·00

The alumina and the phosphoric acid may be separated from each other, in presence of an excess of sulphuric acid, at 60° (B. ?); but whilst the alumina forms a persulphate insoluble in sulphuric acid, and very slightly soluble in cold water, the phosphoric acid forms a liquid sulpho-conjugated acid. The separation is therefore effected by decanting the sulpho-phosphoric acid and washing the persulphate of alumina.

Active Matter of Malt, or Maltin and Diastase.—M. Dubrunfaut.—The author ascribes the following properties to the diastase of Payen. It exists in malt to the extent of one- to two-thousandths; it liquefies 2000 times its weight of starch; it is free from nitrogen, and saccharifies 2000 times its weight of starch (according to Guerin only 15 times). It has no rotatory power; is soluble in weak alcohol, but insoluble in anhydrous alcohol, and not affected by this liquid. It is not altered on solution in water at 75°, but is modified at 100°. Its maximum of activity is at 75°. Maltin, on the other hand, exists in malt to the extent of 1 part in 100; it liquefies two hundred thousand times its weight of starch; it contains from 0·07 to 0·08 of nitrogen, saccharifies a hundred times weight of starch, and possesses a strong lævo-rotatory power; it dissolves in alcohol at 40 to 50 per cent, but is insoluble in, though modified by, strong alcohol. Its maximum activity is below 50°, and it exists not merely in cereals, but in many potable waters.

Extracts from the Transactions of the Chemical Society of Geneva.—These extracts consist of "Certain Derivatives of the Aromatic Ketones," MM. Friedel, Crafts, Ador, and Billiet; "On Alizarin Blue," C. Graebe; "On Naphtho-picric Acid," M. Bourcart; "On Sulpho-Alizaric Acid," M. Bourcart; "Constitution and Certain Derivatives of Desoxalic Acid," H. Brunner; "Attempts to prepare the Tertiary Bases in which an Atom of Nitrogen is linked by its Three Affinities to Atoms of Carbon differently connected among themselves," H. Bungener; "Chemical and Physical Study of Soils suitable for the Establishment of a Cemetery," L. Lossier; "New Method of the Synthesis of Ketons," G. de Becchi; "Solubility of certain Hydrocarbons and other Aromatic Substances of High Boiling-points in Alcohol and Toluen," G. de Becchi.

Composition of certain Complex Oxides of Cobalt and Nickel.—T. Bayley.—From the *Proceedings of the Royal Irish Academy.*

New Process of Manufacturing Manure with Fresh Urine.—Raoul Brullé.—The author's process, which has been patented, is the absorption of urine by recently baked gypsum.

The Height of "Specialité"—Lourdes-water dialysed by M. Bravais.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 8, October 23, 1879.

Researches on the Constitution of the Ferric Hydrates.—Dr. D. Tommasi.—It appears that all these hydrates may be arranged in two series, respectively isomeric, the red and the yellow. The former are obtained by precipitating a ferric salt by potassa, soda, or ammonia. When calcined they present the phenomenon of incandescence; they dissolve readily, even in the weakest acids. Ferric chloride dissolves them in quantity, and the solution gives a precipitate of ferric hydrate on the addition of potassium sulphate or sulphuric acid. They are dehydrated on boiling with water. The yellow hydrates are obtained by oxidising ferrous hydrate or carbonate or magnetic hydrate. If these hydrates are calcined they do not display incandescence; they are sparingly soluble in acids, whether dilute or concentrated; they are not attacked by ferric chloride; if boiled in water they only lose two molecules of water, retaining the third, even if boiled in a concentrated solution of calcium chloride. It is possible that not merely the ferric salts but also the compounds of chrome and aluminium may exist in these two modifications. If the two ferric chlorides are treated with silver nitrate, the one precipitates all its chlorine, whilst the other gives up 4 atoms at first and the two others afterwards. In a similar manner the blue chromium chloride gives up all its chlorine at once, whilst the green chloride gives up two-thirds at first and the remainder afterwards. There ought to exist two ferric sulphates corresponding to the two chromic sulphates. The two latter are distinguished not merely by their colour, but by the fact that the blue sulphate gives up all its acid to baryta, whilst the green sulphate retains a part.

Report on the Methods of Electric Illumination.—M. Tommasi.—The author points out the disadvantages both of the Bunsen battery and of the dynamo-electric machine as employed for the production of the electric light, and proposes a new battery—a modification of that of Bunsen—which can be worked at 7 centimes per hour per element, whilst a similar intensity, obtained with the dynamo-electric machine, costs 19 centimes. The maintenance of 10 burners with the common Bunsen battery costs 50 centimes per hour; with the magneto-electric machine 25 centimes, and with the Tommasi battery 13 centimes. An equal light produced by means of gas at 30 centimes per cubic metre would cost 42 centimes.

Transactions of the Imperial Academy of Sciences of Vienna.—Mineralogical notes on apophyllite, chabasie, plagioclase, and nephrite.

Die Chemische Industrie.
No. 8, September, 1879.

Apparatus for Concentrating Sulphuric Acid.—J. Stroof.—The author shows that the apparatus of Prentice, whose patent is worked by Messrs. Johnson and Matthey, is far superior to all others. If its performance is taken as 100, that of Faure and Kessler, at equal cost, is 79, that of Desmontis Quennessen and Le Brun 76, and that of the old construction only 38.

Behaviour of the Acids of Nitrogen with Sulphuric Acid.—Dr. G. Lunge.—Already noticed.

Determination of the Value of Superphosphates.—H. Albert and F. Siegfried.—The authors have abandoned the use of ammonium tartrate for dissolving the reverted phosphates, as they find that the action of ammonium citrate at equal temperatures and in equal times is more satisfactory. They find a temperature of 17° to 20° preferable.—*Zeitschrift fur Anal. Chemie.*

Annales de Chimie et de Physique,
October, 1879.

Laws of Dispersion of the Dark Thermic Rays and Measurement of their Wave-Lengths.—M. Mouton.—This long and important memoir, of which the first part is here inserted, does not admit of useful abstraction.

Action of Water upon Metallic Sulphides.—MM. de Clermont and Frommel.—The decomposition of metallic sulphides in presence of boiling water is a dissociation of the hydrates of these sulphides effected by heat. The authors prove experimentally that prior to decomposition the sulphides exist as hydrates.

Refrigerating Power of Air at High Pressures.—M. Aimé Witz.—A mathematical paper, not susceptible of useful abstraction.

Researches on the Colouring Matters of Madder.—M. A. Rosenstiehl.—(Fourth and concluding part.)—In this memoir the author describes purpuroxanthin.

Reversion of Superphosphates.—M. H. Joulie.—The author maintains that superphosphates, even when containing much iron and alumina, if prepared with a sufficient quantity of acid, do not undergo a reversion of their assimilable phosphoric acid, but they are apt to remain in a paste-like state. If the dose of acid is smaller, and the action incomplete, the mass dries better, but the assimilable phosphoric acid undergoes reversion. The addition to the superphosphates of calcium carbonate determines immediately the same phenomenon.

Chemical Researches on the Ligneous Papilionaceæ.—MM. P. Fliche and L. Grandeau.—Plants belonging to one and the same family and growing on the same soil differ notably in the quantity and distribution of the starch, in the quantity of the ash, and in that of nitrogen. The percentage composition of the ash varies within still wider limits. The nearer genera approach each other the smaller are their chemical differences.

Annalen der Physik und. Chemie.
No. 10, 1879.

On Newton's Dust-Rings.—E. Lommel.—An extensive paper, not capable of useful abstraction.

On the Law of Stokes.—E. Lommel.—The autho agrees with E. Becquerel, who approves of the conclusion of Lamansky, that the law of Stokes is of universal validity. The experiments of Lamansky, though accurate, merely prove that the mean refrangibility of the light of fluorescence is less than the mean refrangibility of the exciting light.

The Spectrum of Oxygen.—A. Wüllner.—A criticism of the researches of Paalzow, who, in October, 1878, communicated to the Berlin *Academy of Sciences* the description of an oxygen spectrum, consisting essentially of five lines.

Behaviour of Electricity in Attenuated Gases.—F. Narr.—The author considers it indubitable that the process of eradication cannot be alone explained by the presence of dust, mercurial vapour, or watery vapour.

Electro-magnetic Rotation of the Plane of Polarisation of Light in Gases.—A. Kundt and W. C. Röntgen.—The authors show experimentally that air, oxygen, nitrogen, carbonic oxide, carbonic acid, coal-gas, ethylen, and marsh-gas display a rotation of the plane of polarisation in the direction of the positive current, like water and carbon disulphide. The magnitude of the rotation differs manifestly for different gases, other conditions being equal.

Theory of the Poles of a Bar-Magnet.—E. Riecke.—An extensive, mathematical paper, not susceptible of useful abridgment.

Constant Batteries of Bunsen, Grove, and Daniell, especially on the Dependence of their Electromotoric Force on the Concentration of the Liquids.—Carl Fromme.—In a Bunsen element the concentration of the nitric acid has a greater influence than in Groves. The stronger the acid the stronger is the current.

Changes of Density in Steel on Hardening.—Carl Fromme.—The hardening of steel is followed by a decrease of its specific gravity.

Journal de Pharmacie et de Chimie.

October, 1879.

Actions of Life without Air; their Influence on the Chemical Phenomena of Respiration.—M. Pasteur.—The author is led to believe that in the animal economy there take place phenomena of the same order as in fermentation. Oxygen acts not only by effecting combustions, but gives to the cellules an activity whence they derive the power of action beyond the influence of free oxygen, in the manner of the ferment-cells. Direct combustions are of little importance.

Chemical Constitution of the Alkaline Amalgams.—M. Berthelot.—Already noticed.

Constitution and Properties of Dialysed Iron.—M. Personne.—The author shows the insolubility of this dialysed iron in the gastric juice.

Constitution of Bodies.—A sketch of some of the recent researches of Mr. N. Lockyer.

New Condensation Hygrometer.—M. Alluard.

The remaining papers in this issue are either purely pharmaceutical or are reprints of matter already noticed from other sources.

Chemiker Zeitung.

No. 40, 1879.

At the meeting of the "International Association against the Pollution of Rivers, Soil, and Air," Professor Vogt, of Bern, declared that according to his experiments the west side of a house was the warmest, upon which followed, in a decreasing series, the east, south, and north. Baron v. Podenils explained his system of dealing with fœcal matters. He concentrates by heat, and forces the products of combustion through the mass.

At the meeting of Naturalists and Physicians held at Baden-Baden, Prof. Herman, of Zurich, emphatically denounced the anti-vivisection outcry; Prof. Delffs held a lengthy speech on the behaviour of hydrogen sulphide with the heavy metals; Prof. Schwarz, of Graz, gave an account of the "Coloured Derivatives of Orcin," and Dr. Fithia described a fourth mono-nitrophenol; Dr. Brühl spoke on the exploration of chemical constitution by physical means, a problem which, he maintained, cannot be solved by purely chemical procedures. He proposes the law that the non-saturated compounds possess a molecular refraction apparently too great, the excess above the calculated value being proportional to the number of manifold combinations of adjacent atoms.

Decrease of Volume in the Formation and Decomposition of Aqueous Solutions.—M. Müller-Erzbach.—When bodies, solid or liquid, combine with water contraction takes place in almost every instance. In the mutual decomposition of aqueous solutions the contraction is greater the greater the intensity of the chemical action.—*Chem. Central-Blatt.*

Gay Lussac's Hyponitric Acid.—According to H. Goldschmidt this acid is non-existent. The fumes given off on heating *aqua-regia* consist of a mixture of chloride and nitrosyl-chloride.—*Chem. Central-Blatt.*

Qualitative Test for Traces of Mercury.—Ed. Teuber.—The material, dry and finely powdered, is mixed with well ignited iron filings and a little red-lead. The mixture is placed in a crucible upon a layer of red-lead, and covered with a layer of iron-filings. The lid of the crucible is so arranged that all the fumes given off on heating the capsule must impinge upon the bottom of a small gold capsule filled with cold water. Traces of mercury down to 0·0001 grm. may thus be detected.—*Oest. Zeitshchrift Berg. and Huttenw.*

Limits of the Delectability of Carbonic Oxide.—Dr. W. Hempel.—See *Zeitshchrift Anal. Chemie*, xviii., p. 399.

Determination of Commercial Nitrates.—J. de Molins.—The author heats along with potassium hydrate and sulphur. The entire nitrogen of the nitrate is converted into ammonia.—*Monit. Prod. Chim.*

No. 41, 1879.

Distillation of Sulphur with Superheated Steam.—Dr. Gerlach.—The author distils sulphur ores in superheated steam in an apparatus figured in the text, and effects a very considerable increase in the yield as compared with the *calcarone*.

On the Right Use of Chemical Symbols.—Prof. Kraut.—The author urges that except where the constitution of a compound is investigated, the dualistic notation of Berzelius should be used, the atomic weights of the elements being of course corrected.

Congress on Patent Law.—The most important suggestion made is that patents should be granted for chemical products, and not merely as, according to the German law, for the processes by which they are prepared.

New Method for the Detection of Foreign Fats in Butter.—Dr. J. Köttstorfer.—See *Zeitshcrift Anal. Chemie.*, xviii., p. 431.

Determination of Nitrates in Highly Diluted Solutions.—A. R. Leeds.—For the detection of traces of the oxides of nitrogen by reduction with iron in alkaline solutions the use of caoutchouc stoppers should be avoided. After the introduction of the reducing ingredients water should be distilled out of the apparatus as long as traces of ammonia can be detected in the distillate, and not till then should the substance under examination be introduced into the retort.—*Zeitschrift Anal. Chemie.*, xviii. p. 428.

Determination of Caustic Lime in Samples of Crude Burnt Lime.—Dr. H. Bodenbender and Dr. E. Ihlee.—The authors prefer the method of Grandeau. The sample is dissolved in moderately concentrated ammonium nitrate, and the lime thus dissolved is precipitated with ammonium oxalate.—*Zeitschrift Rübenz. Ind.*

Detection of Traces of Nitric Acid or Nitrates in Presence of Large Quantities of Nitrous Acid or Nitrites.—A. Piccini.—The substance in question is dissolved in water along with a sufficient quantity of urea, and this liquid is gradually added to a solution of urea and diluted sulphuric acid. When the reaction is over starch-paste and iodide of potassium are added, and if on the introduction of granulated zinc a blue colour appears a nitrate was present.—*Rev. Scient. Ind.*

Examination of Milk.—H. Ohm.—Thirty grms. well-burnt and powdered gypsum are worked up with the milk to a stiff paste at the time of its setting. Milk of 1·030 sp. gr. at 15° C. congealed in 10 hours, with the addition of 25 per cent of water in 2 hours, with 50 per cent in

90 minutes, and with 75 per cent in 40 minutes. Milk skimmed after standing for 24 hours, spec. gr. 1·033, congealed in 4 hours, with 50 per cent water in 1 hour, and with 75 per cent in 30 minutes.—*Arch. Pharm.*, xii., 211.

Detection of Phosphates.—H. Hager.—The substance—food, drinks, excretions, contents of the stomach, &c.—are mixed with basic acetate of lead to remove hydrogen sulphide, and a part of the mixture is then well shaken up with ether in a glass, which is then closed with a cork, in which is inserted a strip of parchment-paper moistened with silver nitrate. If phosphorus is present the paper is quickly turned a lustrous metallic black.—*Pharm. C. H.*, xvii., p. 327.

MISCELLANEOUS.

The Physical Society.—In addition to the papers announced in our last issue to be read at the meeting to-morrow, Dr. Guthrie, F.R.S., will read a paper on "Prof. Pisani's experiments on the Incandescence of Electrodes."

Society of Arts.—The Programme of this Society for its 126th Session has just been issued. It gives a list of the Papers and Lectures for the Session, so far as they have been arranged. The following are the papers to be read at the evening meetings previous to Christmas:—November 26—"Suggestions for Dealing with the Sewage of London," by Major-General H. Y. D. Scott, C.B., F.R.S. December 3—"Apprenticeship: Scientific and Unscientific," by Sylvanus P. Thompson, D.Sc., Professor of Applied Physics at University College, Bristol. December 10—"Art Vestiges in Afghanistan; the Results of Some Recent Explorations in the Jellalabad Valley," by William Simpson. December 17—"The Panama Canal," by Captain Bedford Pim, R.N., M.P. The dates of the Papers after Christmas are not announced, but the following are among the subjects to be treated:—"Domestic Poisons," by Henry Carr; "Gas Furnaces and Kilns for Burning Pottery," by Herbert Guthrie, C.E.; "The Utilisation of Slag," by Charles Wood; "Art in Japan," by C. Pfoundes; "The Trade and Commerce of the Yenisei," by Henry Seebohm; "Modern Autographic Printing Processes," by Thomas Bolas, F.C.S.; "The History of the Art of Bookbinding," by Henry B. Wheatley, F.S.A.; "Art Ironwork," by J. W. Singer; "The History of Musical Pitch," by A. J. Ellis, F.R.S.: "The Recent History of Explosive Agents," by Professor Abel, C.B., F.R.S.; "Ireland and its Resources," by C. G. W. Lock; "The Future of Epping Forest," by William Paul, F.L.S. Three courses of "Cantor Lectures" are to be given. The First Course is by Dr. Charles Graham, F.C.S., F.I.C. Professor of Chemical Technology at University College, London, on "The Chemistry of Bread and Bread-making." The Second on the "Manufacture of India-rubber and Gutta-percha," by Thomas Bolas, F.C.S. The Third by R. W. Edis, F.S.A., "Art Decoration and Furniture." The first meeting of the Session will be held on the 19th inst., when the Opening Address will be delivered by Lord Alfred S. Churchill, Chairman of the Council.

NOTES AND QUERIES.

Chlorophyll.—Can anyone say where chlorophyll may be obtained in quantity?—Chlor.

TO CORRESPONDENTS.

A. McDougall.—The process has not yet been published. No particulars are known.

"*Address to Students*," *C.N.*, *Sept.* 12, 1879.—The Editor wishes to remove an impression which prevails respecting the authority for the case given of the student who carried off the B.A. prize as well as Honours in Chemistry by dint of an excellent memory. This case was not given on the authority of Professor Huxley, but on that of the writer of the article.

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THE CHEMICAL NEWS.

Vol. XL. No. 1042.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.*

By D. MENDELEEF.

Although seven years have passed since these thoughts absorbed any attention; although other occupations† have drawn my attention from the problem of the elements, which was always getting nearer solution; in short, although I might wish to put this question otherwise than I did seven years ago, still I keep to the same firm conviction that I formerly had on the importance and value of the theorems on which my memoir is based; and this is why I am so gratified to see my ideas exposed to the appreciation of the learned. Several occurrences have aided to make some of the logical consequences of the periodic law popular.

1st. The law I announced has been considered as a repetition in another form of what has already been said by others. The article in the *Berichte der Deutschen Chemischen Gesellschaft*, 1874, p. 348, treats only of the question of priority. It is now certain that the periodic law offers consequences that the old system had scarcely ventured to foresee. Formerly it was only a grouping, a scheme, a subordination to a given fact; while the periodic law furnishes the facts, and tends to strengthen the philosophical question, which brings to light the mysterious nature of the elements. This tendency is of the same category as Prout's law, with the essential difference that Prout's law is arithmetical, and that the periodic law exhausts itself in connecting the mechanical and philosophical laws which form the character and glory of the exact sciences. It proclaims loudly that the nature of the elements depends above all on their mass, and it considers this function as periodic. The formula of the law might be changed; a greater appreciation of this function will be found; but, I believe that the original idea of the periodic law will remain, because it is opposed to the primitive notion that the nature of elements depends on unknown causes, and not on their mass. In 1872 to 1877 Gustavson and Palitzine showed that even the coefficients of simple substitution depend on the atomic weight of elements, in the sense which is in accordance with the periodic law.

2ndly. The periodic law requires changes in the atomic weights of many elements yet incompletely examined; for example, indium, cerium, yttrium, erbium, didymium, &c. Before the existence of this law there was no reason for doubting the generally accepted atomic weights of these elements. At present, since the researches of Rammelsberg, Roscoe, Clève, Hoglund, Hildebrand, and others, have led to the same conclusion as that which is derived from the periodic law, it becomes incontestable that it shows us the truth, which is in fact its support.

3rdly. The periodic law has given the first chance of predicting not only unknown elements, but also of determining the chemical and physical properties of simple bodies still to be discovered, and those of their compounds. The discovery of gallium by M. Lecoq de Boisbaudran, whom I have now the honour of counting as a friend, may be considered as the inauguration of the periodic law, and reckoned amongst the brilliant pages in the annals of science. The properties announced in the *Comptes Rendus*, Nov. 22, 1875, have been confirmed by after study. It will be enough to mention four—the formation of gallium alum, the equivalent of the oxide, the specific gravity of the metal (5·9), and the atomic weight of the element.

It must be admitted that before the periodic law there was no possibility of a similar prediction. It is here to the point to direct attention to the fact that the fusing-point of gallium is so low that it melts at the heat of the hand. This property might be considered as foreseen, but that is not the case; it suffices to look at the following series:—

Mg	Al	Si	P	S	Cl
Zn	Ga	—	As	Se	Br
Cd	In	Sn	Sb	Te	I

It is evident that in the group Mg, Zn, Cd, the most refractory element (Mg) has the lowest atomic weight; but in the groups commencing with S and Cl the most difficultly fusible bodies are the heaviest. In a transitory group, as Al, Ga, In, it is necessary to notice an intermediate fact, the extremes, that is, the heaviest (In) and the lightest (Al) should be less fusible than the middle one, as it is in reality. I would further remark that a property such as the fusion-point is characterised chiefly by the molecular weight and not by the atomic weight. If we had a variation of solid sulphur, not as S^{VI} (or perhaps heavier, as S^{n}) but S^{II}, which form it acquires at 800°, its boiling- and fusion-point would have been much lower. In the same way, ozone, O^{III}, will condense much more easily than oxygen, O^{II}. Experiments made in our laboratory confirm this fact.

The three circumstances mentioned have obliged chemists to direct their attention, distracted by the brilliant material acquisitions which distinguish our epoch, towards the periodic law. I ought now myself to complete what is still wanting on this subject, but for the time being I am occupied with other matters, and I should leave the care of developing this question to the future and to new forces, which will I hope endeavour to bring as the first fruits of the periodic law a new philosophical order, in fixing it by pillars strengthened by new experiments, so as to give greater stability to the edifice already begun. I will add but three brief observations:—

1st. The best way of drawing up the table of elements, so as to show the periodic relations, will, I think, be:—

Typical Elements.

I.	II.	III.	IV.	V.	VI.	VII.
H						
Li	Be	B	C	N	O	F
Na						

Even Elements.										Odd Elements.						
I.	II.	III.	IV.	V.	VI.	VII.	VIII.			I.	II.	III.	IV.	V.	VI.	VII.
										—	—	—	—	—	—	—
—	—	—	—	—	—	—					Mg	Al	Si	P	S	Cl
K	Ca	—	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	—	As	Se	Br
Rb	Sr	Yt	Zr	Nb	Mo	—	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Fe	I
Cs	Ba	La	Ce	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	Er	Di (?)	Ta	W	—	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	—	—
—	—	—	Th	—	Ur	—	—	—	—	—	—	—	—	—	—	—

---

* Considerable attention having been drawn to M. Mendeleef's memoir "On the Periodic Law of the Chemical Elements," in consequence of the newly discovered elements gallium and scandium being apparently identical with his two predicted elements ekaluminium and ekaboron, it has been thought desirable to reproduce the entire article in the Chemical News. The present translation is from the *Moniteur Scientifique*, July, 1879, to which periodical it has been communicated by M. Mendeleef, who prefaces the memoir by a letter. This letter forms the subject of the present article; the memoir will be commenced next week.—*Ed.* C.N.

† Touching the compressibility, the dilation, and the resistance of gases, the temperature of the upper layers of the atmosphere, aërostatics, researches on the origin of petroleum, &c.

The Roman figures show the groups or the forms of combination.

2nd. With regard to new elements recently discovered, I think it necessary to keep silence. Of late years metals have been born and have died, such as Davyum, Mosandrium, &c.; this shows the necessity of caution. It is only necessary to mention Marignac's ytterbium (*Archives des Sciences Physiques et Naturelles*, 1878, Nov. 15, No. 251), because the name of the investigator is itself sufficient guarantee. But, after announcement of the series of new metals of Delafontaine, he himself asked that someone else should make fresh researches in such an inaccessible region as gadolinite. One can still say the same of oxide of didymium; it should be re-examined. The absorption-bands of solutions and the equivalents of oxides are not sufficiently sure to show the individuality of elements; because, in different degrees of oxidation and in salts of different basicity, the absorption-bands and the equivalents of oxides can be heterogeneous for the same elements, as, for instance, in cerium, uranium, iron, chromium, &c.

3rd. I should like to fix the attention of chemists on the three principles which are demonstrated in the last chapter, and also on the consequences which are adduced from their strict application to organic compounds (above all not saturated): by their aid we do without hypotheses, we explain cases of isomerism, and we obtain new consequences as yet unexplained.

D. Mendeleef.

(To be continued.)

THE ALLEGED DECOMPOSITION OF CHORINE.

Dr. H. Endemann, who has written an article in the *Journal of the American Chemical Society* entitled "A Review of the Latest Investigations on the Dissociation of the Elements at High Temperatures," publishes the following letter from Prof. Meyer:—

"Zurich, d 28 Sept., 1879.

"Sehr Geehrter Herr,—In Erwiederung auf Ihr geehrtes Schreiben vom 12 Sept., theile ich Ihnen mit, dass die Mittheilungen der englischen Journale ueber meine Arbeiten welche ueber Gewinnung von Sauerstoff aus Chlor berichten, ohne mein Wissen und gegen meinen Willen veroeffentlicht sind, und das diese Mittheilungen in wesentlichen Punkten voellig inkorrekt sind.—Hochachtungsvoll,

"Prof. Victor Meyer."

[Translation.]

"Zurich, September 28, 1879.

"Dear Sir,—In reply to your favour of September 12th, I would state that the communications in the English journals concerning my investigations which report the separation of oxygen from chlorine, have been published without my knowledge and against my wishes, and that the said communications are entirely incorrect in essential particulars.—Respectfully,

"Prof. Victor Meyer."

BLOWPIPE ANALYSIS.

The increasing appreciation of the value of Blowpipe Analysis in England is shown by the recent publication of the translation of another German work on the subject by one of our first scientific publishers, Messrs. Macmillan.

We shall take an early opportunity of reviewing this little work by Herr Landauer, of Brunswick, who lately visited England at the head of a sanitary commission sent here by that State, but meantime have the pleasure to offer our readers extracts from a letter to Colonel Ross, whose contributions on the subject have so often appeared in this journal. The writer of this letter, whose name we are not at present at liberty to communicate, is obviously one well acquainted with the subject, but we may mention that he is a credit to a body of scientific officers who are admitted throughout Europe to be a credit to this country, the Corps of Royal Engineers.

"Point de Galle, Ceylon,
"Sept. 13th, 1879.

"Dear Sir,—I have to acknowledge your letter, with thanks for the information it contained. I long since saw notices of your new system of Blowpipe Analysis, one stating that your work was the best English authority on the subject. It was only recently that I got out "Griffin's Handicraft," and going over the list of your apparatus I saw that your method must be something very different from the old, so I ordered out a special box both for the blowpipe and separately for the wet way. Your book came to hand afterwards. There is no question that your method is greatly superior to Plattner's, which I think may be considered out of date, and that it is a powerful and logical mode of chemical analysis. . . . I was greatly pleased both with boric and phosphoric acid as vehicles of decomposition, and especially so with the lime borate balls. . . . Your book I found extremely interesting, as one written by an enthusiastic master of his subject can hardly fail to be. From your going to publish an epitome, it is evident that you think with myself that Spon's edition is rather too bulky. . . . The chapter on flame, apparatus, reagents, manipulation can hardly be better, being very intelligible and practical. The apparatus is a great advance on the old kinds. . . . The chapter on colour seems to me to be not in the right place, but I have not as yet made any particular use of analysis by colour. . . . I generally go when in search of information to the next chapter, where the ordinary metals and bases are dealt with. This is very clear throughout, and easily worked from. . . . The last half of your book appeals to three classes of investigators. It might, therefore, form usefully three divisions—one for mineralogists, who would be chiefly geologists and engineers; the next to relate to metals intended for the guidance of chemists and manufacturers; and the third for the use of farmers. This division would be very convenient, because one generally employs the blowpipe according to locality, and oftener for some specific branch than for mere study of the multitudinous specimens, seldom found in any number together out of a cabinet or museum. As to the chapter on farming, it almost seems necessary to follow the order of some textbook: "Church's Laboratory Guide" (Macmillan) is one of the best on agriculturul chemistry that I know. What is required would be to show *seriatim* how all that he accomplishes in the wet way can be attained by the blowpipe, including the physical properties of the soil. The best way of insuring this would be to go right through the book, altering it in brief to blowpipe methods. At present one has to do this each time, wading backwards and forwards through descriptions in pyrology intended for the general student till a result of some kind is obtained. . . . A working chapter on the blowpipe applied to agricultural chemistry would supply a great want. . . . I am more familiar with the wet processes, and as Church lays down very complete instructions can depend upon what I would obtain by this method. But there is no reason except this, I think, for considering the wet way preferable; in fact, the blowpipe system now rests upon exactly the same numerical basis the other does, and the apparatus is much more compact, manageable, and cheap.

"There are, however, processes, such as the volumetric analysis of water, or the analysis of water generally, which do not appear to come within the scope of the blowpipe.—Yours very faithfully,

"A. F. F."

ON THE VAPOUR-DENSITIES OF PEROXIDE OF NITROGEN, FORMIC ACID, ACETIC ACID, AND PERCHLORIDE OF PHOSPHORUS.

By J. WILLARD GIBBS.

(Continued from p. 224.)

Peroxide of Nitrogen.—If we take the constants of the equation for this substance from the paper already cited,* we have—

$$\log\frac{15{\cdot}89(D-1{\cdot}589)}{(3{\cdot}178-D)^2}=\frac{3118{\cdot}6}{t_c+273}+\log p-12{\cdot}451, \qquad (10)$$

t_c denoting the temperature on the centigrade scale. The numbers 3·178 and 1·589 represent the theoretical densities of N_2O_4 and NO_2 respectively. The two other constants were determined by the experiments of Deville and Troost.

The results of these and other experiments at atmospheric pressure, all made by Dumas's method, are exhibited in Table I. The first three columns give the temperature (centigrade), the pressure (in millimetres of mercury),† and the density calculated from the temperature and pressure by equation (10). The subsequent columns give the densities observed by different authorities, and the excess of the observed over the calculated densities. In the first column of observed densities we have one observation by Mitscherlich‡ (at 100·25°) and five by R. Müller.§ The three remaining columns contain each the results of a series of experiments by Deville and Troost.‖ In each series the experiments were made with increasing temperatures, and with the same vessel without refilling. It should be observed that the results of the three series are not regarded by their distinguished authors as of equal weight. It is expressly stated that the numbers in the two earlier series, and especially in the first, may be less exact. The last series agrees very closely with the formula. It was from this that the constants of the formula were determined. The experiments of series I. and II., and those of Mitscherlich and Müller, give somewhat larger values, with a single exception, as is best seen in the columns which give the excess of the observed density. The differences between the different columns are far too regular to be attributed to the accidental errors of the individual observations, except in the case of the experiment at 151·8°, where some accident has evidently occurred either in the experiment itself or in the reduction of the result. Setting this observation aside, we must look for some constant cause for the other discrepancies between the different series.

We can hardly attribute these discrepancies to difference in the material employed, or to air or other foreign substance imperfectly expelled from the flask. For impurities which increase the density would make the divergence between the different series greatest when the densities are the least, whereas the divergences seem to vanish as the density approaches the limiting value. (A similar objection would apply to the supposition of any error in the determination of the weight of the flask when filled with air alone.) But if we should attribute the divergences to an impurity which diminishes the density (as air), we should be driven to the conclusion that the first series of Deville and Troost gives the most correct results, and that all the best attested numbers at temperatures below 90° are considerably in the wrong. It does not seem possible to account for these discrepancies by any causes which would apply to cases of normal or constant density. They are illustrations of the general fact that when the density varies rapidly with the temperature, determinations of density for the same temperature and pressure by different observers, or different determinations by the same observer, exhibit discordances which are entirely of a different order of magnitude from those which occur with substances of normal or constant densities, or which occur with the same substance at temperatures at which the density approaches a constant value. In some cases such results may be accounted for by carelessness on the part of the observers, not controlled by a comparison of the result with a value already known. But such an explanation is inadequate to explain the general fact, and evidently inadmissible in the present case.

It is probable that these discrepancies are in part attributable to a circumstance which has been noticed by M. Wurtz, in his account of his experiments upon the vapour-density of bromhydrate of amylene, in the following words:—"Le temps pendant lequel la vapeur est maintenue à la température où l'on détermine la densité n'est pas sans influence sur les nombres obtenus. C'est ce qui résult des deux expèriences faites à 225 degrés avec des produits identiques. Dans la première, la vapeur a été portée rapidement à 225 degrés. Dans la seconde elle a été maintenue pendant dix minutes à cette température. On voit que les nombres trouvés pour les densités ont été fort différents. [The numbers were 4·69 and 3·68 respectively.] Ce résultat ne doit point surprendre si l'on considère que le phénomène de décomposition de la vapeur doit absorber de la chaleur. et que les quantités de chaleur nécessaires pour produire et la dilatation et la décomposition ne sauraient être fournies instantanément."*

It is not difficult to form an estimate of the quantities of heat which come into play in such cases. With respect to peroxide of nitrogen, it was estimated in the paper already cited that the heat absorbed in the conversion of a unit of N_2O_4 into NO_2 under constant pressure is represented by 7181 a_2. (The heat is supposed to be measured in units of mechanical work.) Now the external work done by the conversion of a unit of N_2O_4 into NO_2 under constant pressure is a_2t. Therefore, the ratio of the heat absorbed to the external work done by the conversion of N_2O_4 into NO_2 is $7181\div t$, or 23 at the temperature of 40° C. Let us next consider how much more rapidly this vapour expands with increase of temperature at constant pressure than air. From the necessary relation—

$$v=\frac{k\,m\,t}{p\,D}$$

where m denotes the weight of the vapour, and k a constant, we obtain—

$$\left(\frac{dv}{dt}\right)_p=\frac{v}{t}-\frac{v}{D}\left(\frac{d\,D}{dt}\right)_p,$$

where the suffix p indicates that the differential coefficients are for constant pressure. The last term of this expression evidently denotes the part of the expansion which is due to the conversion of N_2O_4 into NO_2, and the preceding term the expansion which would take place if there were no such conversion, and which is identical with the expansion of the same volume of air under the same circumstances. The ratio of the two terms is—

$$-\frac{t}{D}\left(\frac{dD}{dt}\right)_p,$$

the numerical value of which for the temperature of 40° is 2·42, as may be found by differentiating equation (10), or,

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* See equation (336) on page 339, *loc. cit.*; also the following equations in which the density is given in terms of the temperature and pressure. In comparing these equations, it must be observed that in (336) the pressures are measured in atmospheres, but in this paper in millimetres of mercury.

† 760 m.m has been assumed as the pressure of the atmosphere in all cases in which the precise pressure is not recorded in the published account of the experiments. The figures inserted in the columns of pressures are in such cases enclosed in parentheses. The same course has been followed in the subsequent tables. With respect to the principal series of observations by Deville and Troost (series III.), it is stated that the barometer varied between 747 and 764 millimetres. A difference of 13 millimetres in the pressure would in no case cause a difference of 0·005 in the calculated densities. In this series, therefore, the errors due to this circumstance are not very serious.

‡ *Pogg. Ann.*, vol. xxix. (1833), p. 220.

§ *Lieb. Ann.*, vol. cxxi. (1862), p. 15.

‖ *Comptes Rendus*, vol. lxiv. (1867), p. 237.

* *Comptes Rendus*, t. lx, p. 730.

with less precision, from the numbers in the third column of Table I. Let us now suppose that equal volumes of peroxide of nitrogen and of air at the temperature of 40° and the pressure of one atmosphere receive equal infinitesimal increments of temperature under constant pressure. The heat absorbed by the peroxide of nitrogen on account of the conversion of N_2O_4 into NO_2 is 23 times the external work due to the same cause, and this work is 2·42 times the external work done by the expansion of the air. But the heat absorbed by the air in expanding under constant pressure is well known to be 3·5 times the work done. Therefore the heat absorbed on account of the conversion of N_2O_4 into NO_2 is (23×2·42÷3·5=)15·9 times the heat absorbed by the air. To obtain the whole heat absorbed by the vapour we must add that which would be required if no conversion took place. At 40° the vapour of peroxide of nitrogen contains about 54 molecules of N_2O_4 to 46 of NO_2, as may easily be calculated from its density. The specific heat for constant pressure of a mixture in such proportions of gases of such molecular formulæ, if no chemical action could take place, would be about twice that of the same volume of air. Adding this to the heat absorbed by the chemical action, we obtain the final result,—that at 40° and the pressure of the atmosphere the specific heat of peroxide of nitrogen at constant pressure is about eighteen times that of the same volume of air.*

But the greater amount of heat which is required to bring the vapour to the desired temperature is only one factor in the increased liability to error in cases of this kind. The expansion of peroxide of nitrogen for increase of temperature under constant pressure at 40° is 3·42 times that of air. If then, in a determination of density, the vapour fails to reach the temperature of the bath, the error due to the difference of the temperature of the vapour and the bath will be 3·42 times as great as would be caused by the same difference of temperatures in the case of any vapour or gas having a constant density. When we consider that we are liable not only to the same, but to a much greater difference of temperatures in a case like that of peroxide of nitrogen, when the exposure to the heat is of the same duration, it is evident that the common test of the exactness of a process for the determination of vapour-densities, by applying it to a case in which the density is nearly constant, is entirely insufficient.

That the experiments of the III. series of Deville and Troost give numbers so regular and so much lower than the other experiments is probably to be attributed in part to the length of the time of exposure to the heat of the experiment, which was half an hour in this series: for the other series the time is not given.

Another point should be considered in this connection. During the heating of the vapour in the bath it is not immaterial whether the flask is open or closed. This will appear if we compare the values of—

$$\left(\frac{d\,D}{dt}\right)_p \quad \text{and} \quad \left(\frac{d\,D}{d\,t}\right)_v,$$

the differential coefficients of the density with respect to the temperature on the suppositions, respectively, of constant pressure and of constant volume. For 40° we have—

$$\left(\frac{d\,D}{d\,t}\right)_p = 0{\cdot}0189, \qquad \left(\frac{d\,D}{d\,t}\right)_v = 0{\cdot}0163,$$

the first number being obtained immediately from equation (10) by differentiation after substitution of—

$$\frac{kmt}{v\,D} \text{ for } p.$$

The ratio of these numbers evidently gives the proportion in which the chemical change takes place under the two suppositions. This shows that only about six-sevenths of the heat required for the chemical change can be supplied before opening the flask, and the remainder of this heat, as well as that required for expansion, must be supplied after the opening. The errors due to this source may evidently be diminished by diminishing the intervals of temperature between the successive experiments in a series of this kind, and also by diminishing the opening made in the flask, which increases the time for which the flask may be left open without danger of the entrance of air. In series III. of experiments by Deville and Troost the intervals of temperatere did not exceed ten degrees (except after the density had nearly reached its limiting value), and the neck of the flask was drawn out into a very fine tube.

In Table II., which relates to experiments on the same substance at pressures less than that of the atmosphere, the principal series is that of Naumann,* which commences a few degrees below the lowest temperatures of Deville and Troost, and extends to −6° C., the pressures varying from 301 to 84 millimetres. These experiments were made by the method of Gay-Lussac. The numbers in the column of observed densities have been re-calculated from the more immediate results of the experiments, and are not in all cases identical with those given in Professor Naumann's paper. Every case of difference is marked with brackets. Instead of the numbers [2·66], [2·62], [2·85], [2·94], Naumann's paper has 2·57, 2·65, 2·84, 3·01, respectively. In some cases the temperatures and pressures of two experiments are so nearly the same that it would be allowable to average the results, at least in the column of excess of observed density. In such cases the numbers in this column have been united by a brace. The greatest difference between the observed and calculated densities is 0·16, which occurs at the least pressure, 84 millimetres. In this experiment the weight of the substance employed is also less than in any other experiment. Under such circumstances the liability to error is of course greatly increased. The average difference between the observed and calculated densities is 0·063. Since these

TABLE II.—PEROXIDE OF NITROGEN.

Experiments at less than Atmospheric Pressure.

PLAYFAIR AND WANKLYN—TROOST—NAUMANN.

Temp.	Pressure.	Density calc. by eq. (10).	Density observed.			Excess of obs. density.		
			P.&W.	T.	N.	P.&W.	T.	N.
97·5	(301)	1·631	1·783			+·152		
27	35	1·90		1·6			−·30	
27	16	1·77		1·59			−·18	
24·5	(323)	2·524	2·52			−·004		
22·5	136·5	2·34			2·35			+·01
22·5	101	2·26			2·28			+·02
21·5	161	2·41			2·38			−·03
20·8	153·5	2·41			2·46			+·05
20	301	2·59			2·70			+·11
18·5	136	2·43			2·45			+·02
18	279	2·61			2·71			+·10
17·5	172	2·51			2·52			+·01
16·8	172	2·53			2·55			+·02
16·5	224	2·59			[2·66]			+·07
16	228·5	2·61			[2·62]			+·01
14·5	175	2·58			2·63			+·05
11·3	(159)	2·620	2·645			+·025		
11	190	2·66			2·76			+·10
10·5	163	2·64			2·73			+·09
4·2	(129)	2·710	2·588			−·122		
4	172·5	2·77			2·85			+·08
2·5	145	2·76			[2·85]			+·09
1	138	2·78			2·84			+·06
−1	153	2·83			2·87			+·04
−3	84	2·76			2·92			+·16
−5	123	2·85			2·98			+·13
−6	125·5	2·87			[2·94]			+·07

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* Similar calculations from less precise data for the bromhydrate of amylene at 225° seem to indicate a specific heat as much as forty times as great as that of the same volume of air.

* Ber. der Deutsch. Chem Gesell., Jahrgang xi. (1879), S. 2045.

differences are almost universally positive, and increase as the temperature diminishes, it is evident that they might be considerably diminished by slight changes in the constants of equation (10) without seriously impairing the agreement of that equation with the experiments of Deville and Troost. But it has not seemed necessary to re-calculate the formula, which, in its present form, will at least illustrate the degree of accuracy with which densities at low pressures and at temperatures below the boiling-point of the liquid may be derived from experiments at atmospheric pressure above the boiling-point. Moreover, the excess of observed density may be due in part to a circumstance mentioned by Professor Naumann, that the chemical action between the vapour and the mercury diminished the volume of the vapour, and thus increased the nnmbers obtained for the density.

The same table includes two experiments of Troost,* by Dumas's method, but at the very low pressures of 35 m.m. and 16 m.m. In such experiments we cannot expect a close agreement with the formula, for the same error in the determination of the weight of the vapour, which would make a difference of 0·01 in the density in experiments at atmospheric pressure, would make a difference of 0·21 or 0·47 in the circumstances of these experiments. In fact, the numbers obtained differ considerably from those demanded by the formula.

There remain four experiments by Playfair and Wanklyn,† in which Dumas's method was varied by diluting the vapour with nitrogen. The numbers in the column of pressures represent the total pressure diminished by the pressure which the nitrogen alone would have exerted. They are not quite accurate, since the data given to the memoir cited only enable us to determine the ratios of the total and the partial pressures. The numbers here given are obtained by setting the total pressure, which was that of the atmosphere at the time of the experiment, equal to 760 m.m. The effect of this inaccuracy upon the calculated densities would be small. Two of these observations agree closely with the formula; and two show considerable divergence, but in opposite directions, and these are the two in which the quantities of peroxide of nitrogen were the smallest. The differences appear to be attributable rather to the difficulty of a precise determination of the quantities of nitrogen and of vapour than to any effect of the one upon the other.

Special interest attaches to experiments at the same or nearly the same temperature, but at different pressures. For with experiments at the same temperature, the constants of the formula which are determined by observation are reduced to one, so that the verification of the formula by experiment cannot possibly be regarded as a case of interpolation. It is not necessary that the temperatures should be exactly the same, for it will be conceded that the formula represents the actual function well enough to answer for adjusting slight differences of temperature; but it is necessary that the range of pressures should be considerable in order that the differences of density should be large in proportion to the probable errors of observation. But the pressures must not be so low that accurate determinations become impossible.

In the experiments of Naumann we see some fair correspondences with the formula in respect to the influence of pressure, especially in the first four experiments of the list, where, if we average the results of the third and fourth experiments, as is evidently allowable, the observed values follow very closely the fluctuations of the calculated, extending from 2·26 to 2·41. In other cases the agreement is less satisfactory. The circumstance that the experiments at the the two highest pressures (301 and 279 m.m.) give results exceeding the two calculated values considerably more than any other experiments at adjacent temperatures may seem to indicate that the densities increase with the pressure more rapidly than the formula allows; but the differences are not too large to be ascribed to errors of observation, and the experiment at the lowest pressure (84. m.m.) also shows a large excess of observed density.

A much more critical test may be found in the comparison of Naumann's experiments with those of Deville and Troost, notwithstanding the interval of about 4° of temperature. The formula requires that a diminution of pressure from 760 to 101 millimetres shall reduce the density from 2·676 at 26·7° to 2·26 at 22·5, notwithstanding the effect of the change of temperature. Experiment gives a reduction of density from 2·65 to 2·28, which is about one-ninth less. This is, it will be observed, a deviation from the formula in the opposite direction from that which the experiments of Naumann alone, or a comparison of the experiments of Troost with those of Deville and Troost, seem to indicate. The experiment here compared with Naumann's belongs to series III. of Deville and Troost. If, instead of this experiment, we should take an average of the experiments at lowest temperatures in series II. and III., the agreement with the formula with respect to the effect of change of pressure would be almost perfect.

Formic Acid.—In Table III. the determinations of

TABLE III.—FORMIC ACID.

Experiments of Bineau.

Temperature.	Pressure.	Density calculated by eq (11).	Density observed.	Excess of observed density.
216·0	690	1·60	1·61	+·01
184·0	750	1·64	1·68	+·04
125·5	687	2·03	2 05	+·02
125·5	645	2·02	2·03	+·01
124·5	670	2·04	2·06	+·02
124·5	640	2·03	2·04	+·01
118·0	655	2·13	(2·14)	(+·01)
118·0	650	2·13	2·13	·00
117·5	688	2·15	2·13	−·02
115·5	649	2·17	2·20	+·03
115·5	640	2·16	2·16	·00
115	655	2·18	(2·13)	(−·05)
111·5	690	2·25	2·22	−·03
111·5	690	2·25	2·25	·00
111	608	2·22	(2·13)	(−·09)
108	[687]	2·30	2·31	+·01
105·0	691	2·35	2·35	·00
105·0	650	2·34	2·33	−·01
105·0	630	2·33	2·32	−·01
101·0	693	2·42	2·44	+·02
101·0	650	2·40	2·41	+·01
99·5	690	2·44	2·52	+·08*
99·5	684	2·44	2·49	+·05
99·5	676	2·44	2·46	+·02
99·5	662	2·43	2·44	+·01
99·5	641	2·42	2·42	·00
99·5	619	2·41	2·41	·00
99·5	602	2·41	2·40	−·01
99·5	557	2·39	2·34	−·05
34·4	28·94	2·82	2·77	−·05
31·5	3·04	2·40	2·60	+·20
30·5	8·83	2·67	2·69	+·02
30·0	18·28	2·81	2·76	−·05
29·0	27·40	2·88	2·83	−·05
24·5	17·39	2·88	2·86	−·02
22·0	25·17	2·95	3·05	+·10*
20·0	16·67	2·93	2·94	+·01
20·0	7 99	2·84	2·85	+·01
20·0	2·72	2·64	2·80	+·16
18·5	23·53	2·98	3·23	+·25*
16·0	15·97	2·97	3·13	+·16*
15·5	2·61	2·72	2·86	+·14
15·0	7·60	2·90	2·93	+·03
12·5	15·20	3·00	3·14	+·14*
11·0	7·26	2·95	3·02	+·07
10·5	14·60	3·01	3·23	+·22*

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* *Comptes Rendus*, t. lxxxvi. (1878), p. 1395.

† *Trans. Roy. Soc. Edin.*, vol. xxii. (1861), p. 463.

Bineau are compared with the densities calculated by the formula—

$$\log \frac{1{\cdot}589(D-1{\cdot}589)}{(3{\cdot}178-D)^2}=\frac{3800}{t_c+273}+\log p-12{\cdot}641 \qquad (11)$$

The observed densities are taken from the eighteenth volume of the third series of the *Annales de Chimie et de Physique* (1846), except in three cases, distinguished by parentheses, which are earlier determinations published in the nineteenth volume of the *Comptes Rendus* (1844). It may be added that the pressure (687) for the experiment at 108° is taken from Erdmann's *Journal für Praktische Chemie* (vol. xl., p. 44), the impression being imperfect in the *Annales*, in the copies to which the author has been able to refer, where the figures look much like 637. (The pressure 637 would make the calculated density 2·28.)

In the column which gives the excess of observed densities, the effect of nearness to the state of saturation is often very marked. Such cases are distinguished by an asterisk. The temperature of 99·5° is below the boiling-point of formic acid, and the higher pressures employed at this temperature cannot be far from the pressure of saturated vapour. With respect to lower temperatures, we have the statement of Bineau that the pressure of saturated vapour is about 19 m.m. at 13°, 20·5 m.m. at 15°, 33·5 m.m. at 22°, and 53·5 m.m. at 32°. By interpolation between the *logarithms* of these pressures (in a single case, by *extrapolation*), we obtain the following result:—

Temperature	10·5	12·5	16	18·5	22
Pressure of sat. vapour	16·6	18·5	22	26·2	33·5
Pressure of experiment	14·69	15·20	15·97	23·53	25·17

Whether the large excess of observed density in these cases represents a property of the vapour, or an incipient condensation on the walls of the vessel which contains it, as has been supposed by eminent physicists in similar cases, we need not here discuss.

If we reject these cases of nearly saturated vapour, as well as the three earlier determinations, there remain twenty-five experiments at pressures somewhat less than one atmosphere in which the maximum difference between the observed aud calculated densities is 0·05, and the average difference 0·016; nine experiments at pressures ranging from 29 m.m. to 7 m.m., in which the maximum difference is 0·07 and the average 0·035; and three experiments at pressures of about 3 m.m., in which the average difference is 0·17. The extraordinary precision of the determinations at low pressures is doubtless due to the large scale on which the experiments were conducted. All the experiments at temperatures below 99° were made with a globe of the capacity of 5½ litres, with a stem of suitable length to hold the barometric column.

The agreement is certainly as good as could be desired, and shows the accuracy of which the method of observation is capable. But in no part of the thermometric scale do we find so great a range of pressures as might be desired, without using pressures too low for accurate results, or observations which are to be rejected for other reasons.—*American Journal of Science.*

PECULIAR REACTION OF AMMONIA ON BRASS.

By JOHN Y. McLELLAN.

While experimenting on the action of liquor ammonia on various metals and alloys with a view to determine the most suitable for the contraction of a certain part in an ammonia plant, I have met with a reaction on brass which, so far as I know, has not before been recorded and of which this note is a preliminary notice. If a small piece of brass or a few brass turnings be covered with liquor ammonia, sp. gr. 0·880, in a closely fitting stoppered bottle, and placed aside for a few days, it will be found that the ammonia has acted on the copper of the brass to such an extent as to produce a solution of a more or less characteristic violet colour, due to the presence of oxide of copper held in solution by ammonia If this solution be still allowed to remain undisturbed for a few days longer free from contact with the air, this violet colour will gradually disappear, leaving a colourless solution, which, however, is no sooner brought in contact with the air by removing the stopper than the violet colour is reproduced, and by again stopping the bottle and leaving it aside the same reaction occurs and may be reproduced over and over again. The production of the violet colour from a colourless solution on exposure to the air does not seem to be the result of oxidation, as on opening the bottle in an atmosphere of carbonic acid the same reaction takes place.

I am at present working up this subject in the hope of finding in what state this colourless solution of copper exists.

Cullochfaulds Chemical Works,
Glasgow, November 10, 1879.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 6, 1879.

Mr. Warren De la Rue, President, in the Chair.

The minutes of the last meeting were read and confirmed. A list of presents to the library was read, and the thanks of the Society voted to the respective donors. The following certificates were read for the first time:—G. S. Allbright, W. J. F. Churchouse, M. Cochrane, W. R. Dunstan, J. J. Hummel, E. Hughes, T. S. Humpidge, F. Hatton, A. Leibius, R. Jones H. F. Morley, H. Newton, J. Parette, G. Stallard, J. M. Wilson.

The President announced that the Council had expended about £300 in purchasing books for reference and circulation. He invited Fellows to offer suggestions as to the purchase of new books and the general improvement of the circulating library.

The Secretary then read a paper by C. O'Sullivan, "*On the Transformation-products of Starch.*" This paper was originally presented to the President of the Société Chimique de Paris on June 18; extracts therefrom were read on July 4; but as the bye-laws of the Council exclude papers longer than eight printed pages, the author thought it desirable to bring the communication before the Society, especially as it appeared from papers published by MM. Musculus and Gruber that these chemists were, to a great extent, unacquainted with the previous work of the author. The author commences by re-asserting that the molecule of starch under the influence of malt extract splits up in one of four ways:—

$$\text{(C.)}\ C_{72}H_{120}O_{60}+H_2O=\overbrace{C_{12}H_{22}O_{11}}^{\text{Maltose.}}+\overbrace{C_{60}H_{100}O_{50}}^{\alpha\text{-Dextrin.}}.$$

$$\text{(B.)}\ C_{72}H_{120}O_{60}+2H_2O=2C_{12}H_{22}O_{11}+\overbrace{C_{48}H_{80}O_{40}}^{\beta\text{-Dextrin I.}}.$$

$$\text{(B}'\text{.)}\ C_{72}H_{120}O_{60}+3H_2O=3C_{12}H_{22}O_{11}+\overbrace{C_{36}H_{60}O_{30}}^{\beta\text{-Dextrin II.}}.$$

$$\text{(A.)}\ C_{72}H_{120}O_{60}+4H_2O=4C_{12}H_{22}O_{11}+\overbrace{C_{24}H_{40}O_{20}}^{\beta\text{-Dextrin III.}}.$$

Other proportions of maltose and dextrin have been observed, but these are due to either the splitting-up of the starch partially according to one equation, and partially according to one or more others, or to the further action of the active agents of malt extract on the dextrin first produced. The proportions of maltose and dextrin represented by the equation of MM. Musculus and Gruber belongs to the latter class. These chemists confirm the author's work as far as it relates to maltose, but have made a serious error (about 2 per cent) in calculating the specific rotatory power, as they have taken 220 m m. of a 1 per cent solution of maltose to give a deviation of 13·5 divisions on the scale of the Soleil-Duboscq instrument. This number should be 13·75. MM. Musculus and Gruber point out at least three dextrins with different optical activities and cupric oxide reducing powers. The author declares the existence of four distinct dextrins to be highly probable, but states that all, when pure, have the same optical activity, but that none are reducing bodies. Soluble starch has the same optical activity as the dextrins, but like them does not reduce when pure. The author then gives details of the preparation and properties of soluble starch and the various dextrins, criticising the statements and methods of MM. Muculus and Gruber, as well as the various products obtained by them. In the second part the author investigates the action of malt extract on the transformed products. At first sight it would seem probable that the starch molecule breaks down first into maltose and α-dextrin; the latter is then converted into maltose and β-dextrin I., which in its turn forms maltose and β-dextrin II., &c. The author has made many experiments to elucidate this question, and finds that the above theory—viz., the breaking down of the starch molecule into dextrin molecules which become smaller at each step—is not supported by all the facts. Continual work with these bodies has forced the author to the conclusion that they are not a series of polymers, but rather a series of bodies of the same molecular weight, in which the difference of behaviour must be accounted for by a difference of relation in the arrangement of the molecules to one another, probably in solution alone We may take it, continues the author, that the molecule of soluble starch, or the dextrin giving a purple with iodine, is simply $C_{12}H_{20}O_{10}$; but that these molecules in solution are arranged in groups of six sixes, all the groups being in an intimate state of tension one with another, so that the motion affecting one under certain conditions affects all under the same condition. In conclusion, the author states that the theory of splitting up and breaking down of the starch molecule, as represented by the equations, does not hold all the facts eliminated, and is not in accord with them. The theory, on the other hand, of the arrangement of the molecules in groups, all dependent one on the other, and capable, therefore, of undergoing a simultaneous movement, and the re-arrangement of these groups attendant upon the hydration of a definite proportion of the molecules in each of them, holds all the facts at present known, and is in perfect accord with all of them. The author is still engaged on the chemistry of the subject, but points out that the physics ought now to be studied, and the heat absorbed or eliminated during the different transformations determined; thus some idea of the character of the apparent work done will be gained.

Dr. Armstrong then read a "*Note on the Formulæ of the Carbohydrates.*" The simplest carbohydrates—dextroglucose and its isomerides—are closely related to mannite and dulcite, as shown by their conversion into one or other of these alcohols by the action of nascent hydrogen, and therefore they are derivatives of the paraffin, normal hexane. Of the three possible formulæ which may be assigned to a body formed from mannite or dulcite by the absorption of 2 atoms of hydrogen, that which represents glucose as being both a aldehyd and a penthydric alcohol,

$$CH_2(OH).CH(OH)CH(OH)CH(OH)CH(OH)COH,$$

appears to be the most probable, as it is the only one which accounts for the formation of saccharic or mucic acids from it on oxidation. The carbo-hydrates of the cane-sugar group are probably related to the glucoses in the same way that ordinary ether is related to ethyl alcohol; moreover, it appears most probable that the simplest carbohydrate of the empirical formula $C_6H_{10}O_5$, *i.e.*, dextrin, and if several exist, the lowest of them, bears a similar relation to the carbohydrates of the cane sugar group, and therefore has the formula $C_{24}H_{40}O_{20}$. Supposing starch to be a body of highly complex formula, the author is inclined to prefer this hypothesis to that advanced by O'Sullivan: there is very little doubt that it bears an altogether different relation to the lower carbohydrates; most probably the relation is of the character of that which obtains between aldehyd and its polymerides, *i.e*, the groups composing the starch molecule are partly held together by the COH groups, these groups being rendered capable of thus acting by their conversion into HC—O— groups. On this hypothesis a number of $C_6H_{10}O_5$ polymerides of varying molecular weight may be conceived to be capable of existing, and bodies such as inulin, glycogen, &c., are not improbable by intermediate terms in such a series. The fact that the dextrins obtained by the decomposition of starch under various conditions are very similar in their properties is not so difficult to reconcile with this hypothesis, if it be assumed, as appears probable, that the polymerisation and formation of higher terms in the series are attended with the expenditure of only a small amount of energy; in this case the polymerides would not, probably, differ greatly from each other in properties. It may be argued that as cane sugar and the dextrins are not cupric oxide reducing bodies, it cannot be assumed that they contain the group COH in their formulæ; probably, however, the power of reducing cupric salts is in no way connected with the presence of COH groups In conclusion, the author considers that there is little doubt that our present theory of isomerism is insufficient and incapable of explaining the isomerism of mannite with dulcite and of the glucoses with one another. The Le Bel hypothesis appears at first sight to be applicable, but there is much evidence tending to show that this hypothesis does not furnish the entire solution of the problem,

The next paper was read by the Secretary, "*On a New Method of Determining Sulphur in Coal,*" by Teikichi Nakamura, of the Engineering College, Tôkiô. The author criticises the methods generally used, the nitric acid and potassium chlorate method, the potassium hydrate method, and the method of fusion with alkali carbonates and nitre, and he finds them all more or less inaccurate or inconvenient. He recommends the following procedure:—3 or 4 parts of the mixed alkali carbonates, or of sodium carbonate, are intimately mixed with one part of coal in very fine powder in a large platinum dish. The mixture is heated at first very gently, a spirit lamp being used, to prevent possible absorption of sulphur, instead of a Bunsen; the heat is then raised slowly without attaining that of visible redness until the surface becomes only faintly grey. No smoke or odorous gases should escape during the whole of the oxidation. The temperature is now raised to a faintly red heat for sixty minutes, at the end of which time the mass is perfectly white or reddish if iron be present. The mass is not to be stirred during the ignition. The residue is treated with water, filtered, and the sulphates determined in the ordinary way. The author quotes some results obtained by his process. To the paper is appended a note by Dr. Divers, stating that the above process was worked out some time before the Chemical News of January 17th was received, which contains a somewhat similar process by Mr. Pattinson, who estimates the sulphur by heating a mixture of coal and calcium hydrate in a muffle.

At the conclusion of this paper, Dr. Gilbert took the chair.

The next paper was read by the Secretary, "*On the Bromine Derivatives of β-Naphthol,*" by A. J. Smith.

The author prepared β-mono-brom-napthol by adding to a tolerably concentrated solution of β-napthol in glacial acetic acid, the theoretical amount of bromine mixed with an equal volume of glacial acetic acid; the bromine is added drop by drop, and the mixture kept cool. On standing colourless needles with an adamantine lustre crystallise out. These were purified and analysed. β-mono-brom-napthol is soluble in alcohol, ether, and benzene, melts at 84° C., begins to decompose at 130°; when oxidised by alkaline permanganate it yields orthophthalic acid. The author prepared β-tetra-brom-napthol in a similar way: on oxidation it yielded monobromophthalic acid. In conclusion, the author discusses the bearing of his results on the constitution of these bodies.

The next paper was read by the Secretary, "*Notes on the Dissociation of Ammonia Iron Alum*," by J. S. Thomson. When a dilute neutral solution of a ferric salt is heated, it dissociates, and a basic salt is precipitated. This basic salt is readily soluble in dilute sulphuric acid, if an acid of known strength be employed, and the quantity necessary to bring about the desired solution be known, an insight into the nature of the decomposition can be arrived at. The author refers to the previous work of Krecke, Wiedemann, Tichborne, Naumann, and others. Several series of experiments were made Taking the mean of these, the quantity of sulphuric acid required to prevent dissociation for each addition of 10 c.c. of water, after 50 c.c., when ammonia iron alum equal to 0·1 grm. Fe_2O_3 is used, was found to be 0·0186 grm.; if 0·15 grm. Fe_2O_3 be used, the quantity of H_2SO_4 was 0·02479 grm. The addition of sulphate of ammonia equal to 0·05 ammonia necessitates an additional quantity of sulphuric acid equal to 0·05005 grm. Ammonia salts exert their influence when present as double salts. Ammonia alumina alum, the double sulphates of ammonia and magnesia, and of ammonia and zinc were used. Potash salts exert a still more powerful influence in promoting dissociation. A solution of ammonia iron alum containing more than 1 grm. in 14·37 c.c. does not dissociate on boiling. The dissociation begins in more dilute solutions, and increases regularly, as the above results prove, with each addition of water.

The next paper was read by the Secretary, *On α-Methyl Oxysuccinic Acid, the Product of the Action of Anhydrous Hydrocyanic Acid upon Aceto-acetic Ether*," by G. H. Morris. Demarçay (*Comptes Rendus*, lxxxii., 1337) has described an acid, obtained as above, under the name of oxypyrotartaric acid, as an unstable uncrystallisable syrup whose barium salt is decomposed by boiling with excess of water. The author, at the suggestion of Wislicenus, has prepared the body according to the directions of Demarçay. The thick brown syrup thus obtained was purified by solution in water precipitated with lead acetate, the lead salt treated with sulphuretted hydrogen, the solution filtered, evaporated, treated with ether, until finally the ethereal solution, after standing a few days in the air-pump vacuum, deposited the pure acid in star-like groups of needles, deliquescent, and melting at 108°. The following salts were prepared and analysed;—The barium salt, which, when pure, did not decompose on boiling with water; the calcium, potassium, silver, lead, and copper salts, most of which are deliquescent. The author has investigated the action of fuming hydriodic acid and the products of the dry distillation of the acid. In conclusion, he discusses the constitution of some of the isomers of α-methyl oxysuccinic acid, and assigns the following formulæ:—

$$\text{Citramalic acid}\left\{\begin{array}{l}CH_3\\ CHCOOH\\ CHOH\\ COOH\end{array}\right.$$

$$\text{Itamalic acid}\left\{\begin{array}{l}CH_2OH\\ CHCOOH\\ CH_2\\ COOH\end{array}\right.$$

and

$$\alpha\text{-methyl oxysuccinic acid}\left\{\begin{array}{l}CH_3\\ COHCOOH\\ CH_2\\ COOH\end{array}\right.$$

The next paper was read by the Secretary, "*On the Action of Phosgene on Ammonia*," by H. J. H. Fenton. When these gases are mixed, a white neutral amorphous substance is produced, which has been shown by Regnault and others to consist of ammonium chloride, a substance identical or isomorphous with urea, and in addition small quantities of guanidine, cyanuric acid, &c. (Bouchardat). The author prepared some quantity of this white substance, and obtained a small quantity of guanidine, which he identified by its crystalline form, and some urea, which was identical with ordinary urea in its behaviour with hypochlorites and hypobromites (*Journ. Chem. Soc.*, July, 1878), and in other respects. The author concludes that either carbamide and urea are identical, or that symmetrical carbamide has not been obtained by this method.

The next paper was read by the Secretary, "*On the Rehydration of Dehydrated Metallic Oxides*," by C. F. Cross. The author has obtained various anhydrous basic metallic oxides by igniting the precipitated hydrates. These oxides he exposed at the ordinary temperature to an atmosphere saturated with aqueous vapour. Rehydration occurs up to a definite limit of a molecular character, attended in most cases with a change of volume. He has investigated thus the oxides of aluminium, chromium, cobalt, iron, and copper.

The following paper was taken as read: "*On Alizarin Blue*," by G. Auerbach. About eighteen months since a blue colouring matter was brought into the market as a substitute for indigo. It is now disused on account of its high price and its unstable nature when exposed to sunlight. The researches contained in this paper were finished in May, 1878. The author gives a *resumé* of previous work on the subject, and recommends the following method of preparation:—1 part of dry mono-nitro-alizarin, 5 parts of concentrated sulphuric acid, and 1½ parts of glycerin (sp. gr., 1·262), are mixed and heated gently. Reaction commences at 107° C., becomes violent, the temperature rising to 200°. Much frothing takes place, with evolution of sulphurous acid and acrolein. The whole mass, when frothing has subsided, is poured into water, boiled up and filtered, the residue being boiled out three or four times with dilute sulphuric acid. The mixed filtrates are allowed to cool, and the blue separates in brown crystals. These are purified by mixing with water and adding borax till the solution becomes brownish violet, the blue with the boric acid forming an insoluble compound. This residue is washed, decomposed with an acid, and the pure blue obtained as a violet silky paste. If required perfectly pure, it must be crystallised successively from its various solvents, high-boiling naphtha, amylic alcohol, and glacial acetic acid. When pure it forms brown shining needles, melting 268—270°. It has the formula $C_{17}H_{11}NO_4$. Salts were prepared and analysed, but the results were not satisfactory, as it was difficult to obtain them quite pure. Bromine derivatives were also prepared and examined. The action of chlorine, zinc dust, acetic anhydride, &c., have also been studied. The author discusses the constitution of the blue, and thinks it must be closely related to the aldehydines discovered by Ladenburg, which are formed when aromatic orthodiamides act upon aldehyds.

The Society then adjourned to November 20th, when the following papers will be read:—"A Chemical Study of Vegetable Albinism," Part II.; and "The Respiration and Transformation of Albino Foliage," by A. H. Church; "On the Estimation of Manganese Oxides," by S. Pickering; "A Contribution to the History of Putrefaction," by C. T. Kingzett; "Notes on Manganese Dioxide," by C. R. A. Wright and A. C. Menke.

PHYSICAL SOCIETY.

Ordinary Meeting, November 8, 1879.

Prof. W. G. Adams in the Chair.

The meetings of this Society were resumed for the season on Saturday, November 8.

The first paper read was "*On an Analogy between the Conductivity for Heat and the Induction Balance Effect of Copper-tin Alloys*," by W. Chandler Roberts, F.R.S. Mr. Roberts traced a remarkable resemblance between a curve representing the induction balance effect of the copper-tin alloys published by him in June last, and the curve of Calvert and Johnston for the conductivity of heat, and, on the other hand, he showed that the induction curve does not agree with Matthiessen's curve for the electric conductivity of the same alloys. The author showed that the two alloys which occupy critical points of the curve, $SnCu_3$ and $SnCu_4$, are of much interest. Possibly both are chemical combinations, and the wide difference in the position they occupy probably marks a difference of allotropic state. For the solution of such questions, however, Mr. Roberts considered that we might look with confidence to Prof. Hughes's beautiful instrument, which, he hopes, will also enable us to determine whether the relation between conductivity for heat and electricity is really as exact as it has hitherto been supposed to be.

As supplementary to this subject Dr. O. J. Lodge stated that he had compared the conductivity of six bars of the tin copper alloys, measured by the balance and by the Wheatstone bridge, and found them to agree very closely on the whole. The bridge results confirmed the resemblance traced by Mr. Roberts still more than the induction balance results.

Prof. Hughes expressed his opinion that existing tables of metal-conductivity were erroneous. They disagreed among themselves, and the induction balance showed that it was impossible to get two pieces of the same metal exactly alike; hence the variation of specific conductivity results.

Prof. Ayrton stated that at a former meeting he had suggested that the electric inertia of the different specimens of metal tested might cause the difference between the results obtained by the Wheatstone bridge and the induction balance. Mathematical calculation had since led him to the conclusion that the inductive effect is not proportional to the resistance of the metal tested, but to a *power* or exponential of the resistance.

Prof. Hughes replied that as the inductive effect of the metal was destroyed by cutting it so as to interrupt the circuit in it, it was reasonable to suppose that the said effect was due to induced currents circulating in the metal, and therefore was proportional to the conductivity of the metal.

Capt. Armstrong exhibited a standard Daniell cell formed of porcelain vessel with a porous partition dividing it into two compartments. In one the zinc plate was immersed in a solution of sulphate of zinc; in the other the copper plate in a solution of sulphate of copper. To use the cell as a standard, it was only necessary to connect the two liquids by a cotton string moistened with water. This arrangement prevented mixing of the liquids, as the string could be withdrawn after use. The resistance was high, but it was a constant standard of electromotive force.

Prof. Guthrie mentioned that Prof. Pirani, of Melbourne, in a letter to him had signalled the fact that when a dilute acid was being electrolysed, the positive electrode, if made of iron, became incandescent below the surface of the liquid. Prof. Guthrie had found this to be true not only for iron, but for other metals, and that it could hardly be due to oxidation, because it took place not only at the cathode or positive electrode, where oxygen was evolved, but also at the anode, where hydrogen was evolved. The incandescence appeared to him to be due rather to resistance. The author exhibited his experimental results, which he did not doubt had already been obtained by Prof. Pirani himself. The positive electrode when immersed in the electrolyte was seen to get red-hot and to wobble about. As the liquid heated the red glow became fainter. The negative electrode, on the other hand, emitted a bright light, accompanied by a sputtering noise. The light was tinged with the characteristic colour of the flame of the metal of which it was composed; in the case of a copper electrode, for example, it was greenish. These effects were shown by Prof. Guthrie with iron, copper, and platinum electrodes, in dilute sulphuric and dilute nitric acid.

In reply to Prof. Adams, Prof. Guthrie said he had not yet examined the flame by the spectroscope; and in reply to Prof. Foster, he stated that the battery power used was 50 Grove's cells. He asked for suggestions as to the true cause of the phenomenon.

CORRESPONDENCE.

NORMAL SOLUTIONS.

To the Editor of the Chemical News.

Sir,—What is a normal solution? Unfortunately the term seems to be used in two distinctly different senses. By Sutton, whose book is best known to English chemists, the term is employed to signify a standard solution containing one *equivalent* of the active constituent in 1000 measures of water. I have not Sutton's work before me, but he uses the term in the same sense as I have done in my "Commercial Organic Analysis," in which a normal solution is defined (page 20) as "one containing in 1000 cubic centimetres such an amount of the active constituent as will combine with, replace, or oxidise 1 grm. of hydrogen." According to this definition, the following are the strengths of typical normal solutions:—

			Grms. per litre
Normal caustic soda	contains	..	$NaHO = 40$
,, carbonate sodium	,,	..	$\frac{Na_2CO_3}{2} = 53$
,, baryta water	,,	..	$\frac{BaO}{2} = 76{\cdot}5$
,, hydrochloric acid	,,	..	$HCl = 36{\cdot}5$
,, sulphuric acid	,,	..	$\frac{H_2SO_4}{2} = 49$

Similarly the following solutions are decinormal:—

Decinormal silver nitrate	contains ..	$\frac{AgNO_3}{10} = 17{\cdot}0$
,, mercuric chloride	,, ..	$\frac{HgCl_2}{20} = 13{\cdot}55$
,, potassium permanganate		$\frac{KMnO_4}{50} = 3{\cdot}162$

The advantage of the above arrangement is that all "normal" solutions are of exactly corresponding strength, and those similar in nature may be substituted one for another.

By Fleischer, a normal solution is understood to mean a liquid containing the *atomic weight* in grammes in 1000 c.c. As he employs the old atomic weights, in most cases the above strengths are called normal; but in the translation of his book by Mr. M. M. Pattison Muir, the doubled atomic weights are used with the consequence of very serious obscurity. Thus, while normal caustic potash would be held to contain 39·1 grms. of K per litre, we are told that "a normal solution of potassium carbonate is prepared by dissolving 138·2 grms. of potassium carbonate in 1000 c.c. of distilled water" (p. 37). Hence such a solution contains 78·2 of K, and is twice as strong as the caustic alkali, or as the normal potassium carbonate of the original German.

The confusion is still greater when permanganate comes to be used. In the original German, Fleischer calls a solution of 32 grms of potassium permanganate in 1 litre of water, $\frac{2}{10}$ normal. It is true that this solution is absurdly strong, and is capable of doing ten times the work attributed to it by the author. Mr. Muir has corrected this in an erratum, but in the text of his translation he actually doubles the strength of the above solution, recommending one containing 64 grms. per litre. Hence we have the following confusion in nomenclature.

According to Fleischer, $\frac{2}{10}$ normal permanganate contains 32 grms. per litre, or, if this large amount be due to printer's error, 3·2 grms. per litre.

According to his translator, Muir, $\frac{2}{10}$ normal permanganate contains 6·4 grms. per litre, though it is doubtful, owing to the erratum, whether he would not consider that the solution so described ought to contain 64 grms. per litre.

According to Sutton, $\frac{2}{10}$ normal permanganate contains 6·324 grms. per litre.

That the nomenclature of a standard solution should vary according as the writer employs the old or doubled atomic weights must be held to be highly inconvenient, to say the least of it, though Sutton (compare first with later editions) has wholly avoided any such source of confusion. According to the principle adopted by Mr. Muir, even the employment of the same atomic weights will not always save us, for a standard solution of permanganate will be differently called according as its employer considers the salt in solution to be $KMnO_4$, or disregards its isomorphism with $KClO_4$, and prefers to write it $K_2Mn_2O_8$.

One other instance of this confusion of terms. Mr. J. B Hannay, in his paper on the "Volumetric Estimation of Cyanides,"* calls a solution containing 27·1 grms. of mercuric chloride to the litre "*deci*normal," although a litre would correspond to *two*-tenths of an atom of cyanogen.

As may be gathered from the foregoing remarks, I myself prefer Sutton's interpretation of the term "normal" as applied to standard solutions, but I write this letter not so much to advocate my own views, as to point out the confusion which exists in the hope that chemists may avoid using a well known term in a different sense from that in which it has been commonly employed.—I am, &c..

Alfred H. Allen.

Sheffield, Nov. 10, 1879.

Journ. Chem. Soc., 1878, ., p. 245.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances. l'Académie des Sciences. No 16, October 20, 1879.

Observations of Magnetic Declension, Inclination, and Horizontal Intensity in the Basin of the Mediterranean.—M. de Bernardière.—Table of results.

The Saccharimeter of Laurent.—L. Laurent.—A description of this instrument with figures. It is said to yield more light and more distinctness, and the reflections in the tubes are suppressed.

No. 17, October 27, 1879.

Galvanic Oxidation of Gold.—M. Berthelot.—Grotthuss observed the dissolution of a gold wire used as a positive pole in sulphuric acid traversed by the current. M. Chevreul having suggested that this effect might be due to the formation of persulphuric acid, certain experiments were undertaken to solve the question. The statement of Grotthus was confirmed. Gold was rapidly dissolved, even in dilute sulphuric acid, a part being reprecipitated at the negative pole. Nitric acid also attacks gold under the same conditions, but phosphoric acid and potassa have no appreciable action. The effect of sulphuric and nitric acids upon gold is not due to ozone, since oxygen charged with ozone has no action upon gold in presence of water, whether pure or mixed with sulphuric or nitric acid. Persulphuric acid, even when containing oxygenated water, does not attack gold.

Decomposition of Hydro-selenic Acid by Mercury.—M. Berthelot.—Hydro-selenic acid gas preserved in bottles for some years, at common temperatures and in contact with mercury, is slowly decomposed, forming mercury selenide.

Critical Reflections on the Experiments Concerning Human Heat.—M. Hirn.

Specific Heats and Melting-points of Various Refractory Metals.—J. Violle.—The specific heat of iridium, like that of platinum, increases regularly with the temperature. The mean specific heat of gold varies little up to 600°, and then increases sensibly on approaching the melting-point. The melting-points given are:—Silver, 954°; gold, 1035°; copper, 1054°; palladium, 1500°; platinum, 1775°; iridium, 1950°.

Chloride of Lime Battery.—A. Niaudet.—The battery has for its positive electrode a plate of zinc, and for its negative electrode a plate of coke surrounded with fragments of coke. The zinc is placed in a solution of common salt; the coke is surrounded with chloride of lime, in a vessel of biscuit ware or of parchment paper

Combinations of Hydrogen Phosphide with the Hydracids, and their Heats of Formation.—J. Ogier.—The author has studied the hydrochlorate, hydrobromate, and hydriodate of hydrogen phosphide. The formation-heat of the latter compound is smaller than that of ammoniacal gas, which is conformable with analogies. The formation-heats of the ammoniacal salts are also notably greater than those of the phosphoretted compounds.

On Erbia.—P. T. Clève.—See Chemical News, vol. xl, p. 224

Commercial Trimethyl-amin.—E. Duvillier and A. Buisine.—The authors re-affirm their former conclusions concerning the trimethyl-amin prepared by the process of M. Vincent, in which they have further detected ethylamin and oxamids.

Ordinary Cellulose.—M. Franchimont.—The author adds to a mixture of 1 part of cellulose and 4 parts of acetic anhydride a little sulphuric acid, when a brisk reaction is set up and the cellulose disappears, whilst the liquid becomes coloured. The whole is then thrown into a large excess of cold water, which gives a copious white precipitate. The precipitate is washed in cold water and dried in the air, and is next introduced into alcohol, which dissolves a part and turns slightly yellow. It is filtered, washed in alcohol, and the residue dissolved in boiling alcohol. The solution deposits acicular crystals, composed of $C_{46}H_{54}O_{27}$. It seems to be an eleven times acetylated derivative of a triglucose, $C_{18}H_{32}O_{16}$.

On Glucose.—M. Franchimont.—The author describes an octacetylic diglucose, which has entirely lost the tendency to oxidation present in glucose.

Researches on Colour-blindness.—J. Macé and W. Nicati.—The authors have sought to obtain comparative measurements between the quantities of light perceived in the different parts of the spectrum by the colour-blind on the one hand, and by the normal eye on the other. A red glass which scarcely lessens the vision of the normal eye diminishes remarkably that of a red colour-blind eye.

Justus Liebig's Annalen der Chemie,
Band 199, Heft 1.

Separation of the Heavy Metals of the Ammonium Sulphide Group.—C. Zimmermann.—Inserted at length.

Coto-barks and their Characteristic Constituents.—J. Jobst and O. Hesse.—This bark is probably derived not, like the true cinchonas, from a Rubiaceous plant, but from one of the Laurineæ or the Terebinthinaceæ. It contains a principle, which the authors name cotoin, $C_{22}H_{18}O_6$. Its reactions and derivatives are described at some length.

The Non-existence of Pentathionic Acid.—W. Spring.—The substance hitherto known as pentathionic acid is simply tetrathionic acid. On passing sulphurous acid and sulphuretted hydrogen into water, the former being maintained in slight excess, a liquid is obtained which distinctly decolourises indigo, and which is consequently the hydrosulphurous acid of Schützenberger.

Certain New Basic Salts of Mercury Sulphide.—W. Spring.—The author has analysed the compound produced on adding tetrathionic acid to an aqueous solution of mercurous nitrate—a yellow amorphous flocculent body, insoluble in water. It is a trithio-basic mercury sulphate. When treated with nitric acid it is gradually converted into a white body—mono-thio-basic trisulphate.

Bromoxyl Derivatives of Benzol.—R. Benedict.—The author describes the formation of tribrom-phenol-brom, its behaviour with alcohol, with tin and hydrochloric acid, with aniline and phenol, and with sulphuric acid.

Normal Paraffins.—C. Schorlemmer.—The results of this investigation show that during the action of chlorine upon normal hexan from mannite, a secondary chloride is formed in larger quantity along with the primary. The normal paraffins of mineral oil have always a higher specific gravity than those from other sources.

Suberic and Azelaic Acids.—R. S. Dale and C. Schorlemmer.—On treating cork with 4 parts of nitric acid at 1·30, the clear liquid contained in addition to suberic acid abundance of azelaic acid, oxalic acid, and other acids not yet further examined, and smeary nitrogenous compounds. Suberon on treatment with nitric acid yields an aldehyd of α-pimelic acid. The pimelates of silver, calcium, and barium are described.

Glucoside of White Mustard Seed.—H. Will and A. Laubenheimer.—Sinalbin has the composition—

$$C_{30}H_{44}N_2S_2O_{16}.$$

The authors examine the behaviour of this compound with silver nitrate, mercuric chloride, and myrosin.

Chemiker Zeitung.
No. 42, 1879.

At the Congress of Naturalists and Physicians Prof. Engler discoursed on the dangers of petroleum, and exhibited his new instrument for ascertaining its safety. An induction spark is used to ignite the vapours given off on heating the oil to 35°. Prof. Schrœder spoke on the stere of chlorine and oxygen, and Von Babo on determining the density of very small quantities of gas. Dr. Dabner (Döbner?) discoursed on the action of benzoyl-chloride and benzo-trichloride upon the phenols. Dr. Engler read a paper on the action of metals upon petroleum, and Prof. Volhard spoke on the compounds of manganese. For its detection he heats nitric acid and red-lead to ebullition, and adds drop by drop the dilute solution under examination. If manganese is present there is formation of potassium permanganate. Prof. Böttger spoke on the explosions sometimes produced by the action of sodium on water. He considers that the sodium peroxide formed gives off oxygen, which combines with the liberated hydrogen. Dr. Witt described the constitution of the gases evolved by the action of nitric acid upon arsenious acid. Nölting, of Geneva, spoke on the formula of naphthaline, and Dr. Hesse closed the sectional meeting with a paper on quinhydron. On the 23rd September, Prof. Jäger, of Stuttgart, gave, in the Conference Hall of the Gymnasium, a demonstration his method of examining odours (neural-analysis) and on the odours themselves. At the last general meeting the professor spoke on the influence of the temper. Amidst boisterous merriment he appealed to all mothers present if children, when in a good humour, did not give off a pleasant odour, but a disagreeable one when cross or fretful. The lecturer ended amidst hisses. The number of members of the Congress this year was 1700.

Action of Bromine upon Cane-Sugar.—O. Griesshammer.—The products are a gluconic acid, a carbohydrate resembling fructose, and a gum-like body. The acid is merely an isomer of the gluconic acid of Hlasiwetz.

Volumetric Determination of Magnesium.—Dr. H. Precht.—The author precipitates the soluble magnesian salts with potassa lye of known strength, and determines the excess of the latter with standard acid.

Apparatus and Methods for Testing Petroleum.—Dr. Skalweit.—The author gives the preference to the petroleum pyrometer of Sintenis.—*Hann. Monatschrift.*

Simple Method of Testing Petroleum.—Dr. L. Janke and Dr. A. Barth.—The authors heat in the water-bath, raising the temperature to 100° F. in ten minutes. At 95° they stir the oil, and at 100° F. they bring the flame of an ordinary match in direct contact with the liquid.—*Hann. Monatschrift.*

MISCELLANEOUS.

The Royal Institution.—The Christmas Lectures, adapted to a juvenile auditory, will this year be given by Professor Tyndall, the subject being "Water and Air."

Foundation of a New Chemical Chair.—Mr. Mark Firth has signified his wish to found a Chair of Chemistry in connection with Firth College, Sheffield. He proposes to invest a sum sufficient to produce an annual income of £150, and this, together with the fees of students, will amount, it is believed, to a handsome sum. Mr. Firth proposes that the appointment shall be first filled by Dr. Carnelley, of Owens College, Manchester. Mr. Firth built the College bearing his name, contributing at the same time £20,000 towards the general endowment fund.—*The Medical Press and Circular.*

NOTES AND QUERIES.

Polarimeter.—I should be obliged if you would be good enough to inform me through the Chemical News the best form of polarimeter for determining the amount of sugar in saccharine fluids, and the rotary power of other liquids.—J. C. H.

MEETINGS FOR THE WEEK.

Wednesday, Nov. 19th.—Society of Arts, 8. First Ordinary Meeting. Opening Address of the 126th Session, by Lord Alfred S. Churchill.

— Society of Public Analysts, 8. "On the Mineral Constituents of Cinnamon and Cassia," O. Hehner. "On the Determination of Carbonic Acids in Carbonates," G. W. Wigner. "On the Examination of Coffee," A. H. Allen. "Note on Arsenic in Playing-cards," Dr. Wallace. "Note on the Discrimination of Starches by means of Polarised Light," Dr. Tripe.

Thursday, 20th.—Chemical, 8. "A Chemical Study of Vegetable Albinism: Part II., Respiration and Transpiration of Albino Foliage," A. H. Church. "Estimation of Manganic Oxide and Potassium Bichromate," Spencer Pickering. "Contributions to the History of Putrefaction," C. T. Kingzett. "Notes on Manganese Dioxide," C. R. Alder Wright and A. E. Menke.

— Royal, 8·30.

Saturday, 22nd.—Physical, 3. "On a Retention Image Photometer," Dr. F. Guthrie.

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INSTITUTE OF CHEMISTRY.

The President has offered Two Prizes of £50 each for the two best original investigations involving Gas Analysis. These Prizes will be open to Associates, and to all persons (except Fellows of the Institute) who shall before the 31st December next have qualified for the Associateship in all respects short of passing the prescribed practical examination, and successful competition for these prizes will be accepted in lieu of such practical examination.—Further information may be obtained on application to the Secretary, Mr. C. E. GROVES, Somerset House Terrace, W.C.

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THE CHEMICAL NEWS.

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THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 232.)

EVEN as, up to the time of Laurent and Gerhardt, the words "molecule," "atom," and "equivalent" were used one for the other indiscriminately in the same manner, so now the terms "simple body" and "element" are often confounded one with the other. They have, however, each a distinct meaning, which it is necessary to point out, so as to prevent confusion of terms in philosophical chemistry.

A "simple body" is something material, metal or metalloid, endowed with physical properties, and capable of chemical reactions. The idea of a molecule corresponds with the expression of a "simple body;" a molecule is made up of one atom, as in the case of Hg, Cd, and others; or of several atoms, such as S_2, S_6, O_2, H_2, Cl_2, P_4, &c.

A simple body is able to show itself under isomeric and polymeric modifications, and it is only distinguished from a compound body by the homogeneity of its material parts. But in opposition to this, the name of "element" must be reserved for characterising the material particles which form simple and compound bodies, and which determine their behaviour from a chemical and physical point of view. The word "element" calls to mind the idea of an atom; carbon is an element; coal, diamond, and graphite are simple bodies.

The principal end of modern chemistry is to extend our knowledge of the relations between the composition, the reactions, and the qualities of simple and compound bodies, on the one hand; and, on the other hand, the intrinsic qualities of elements which are contained in them; so as to be able to deduce from the known character of an element all the properties of all its compounds.

For example, saying that carbon is a tetratomic element, is making known a fundamental property which appears in all its combinations.

The elements count among their properties, which can be measured exactly, their atomic weight, and the power of showing themselves under the form of different compounds.

Alone amongst their properties, the two above mentioned bring in their train a number of facts. The last has given rise to a special theory on the atomicity (valency) of elements. Amongst the other properties of elements which influence the character of bodies, the physical properties (such as cohesion, capacity for heat, coefficient of refrangibility, spectral phenomena, &c.) have been up to the present time too incompletely studied for us to be able to generalise them in a rigorously philosophical manner. What we know of these properties is still insufficient and defective in comparison with our knowledge on the atomic weights and the atomicity of elements. However, it has already been often noticed that the physical properties depend one on another, that the atomic weights, and principally the molecular weights of compounds, are equally in intimate relation with them. It is principally the fact, that it is easy to measure these properties exactly, that has induced us to make these comparisons. It is by studying them, more than by any other means, that we can conceive the idea of an atom and of a molecule. By this fact alone we are enabled to perceive the great influence that studies carried on in this direction can exercise on the progress of chemistry.

The above-mentioned measurable properties are by no means the only ones possessed by the elements. They have beyond these a series of properties which have not yet been able to be measured, but which still contribute to their recognition. These last have received the name of chemical properties. Certain elements do not combine with hydrogen; they have, according to the recognised term, a basic character, or, in other words, they absorb oxygen and form bases; they form salts when combining with chlorine; other elements (called acidifying elements) do combine with hydrogen; with oxygen they only form acids, and with chlorine only chloranhydrides. Thirdly, there are elements which form the link between the first and second classes; and fourthly, there are elements which in their forms of higher oxidation have an acid character, and when less oxidised a basic character. Science does not as yet possess any process by which these properties can be measured, but still they are counted among the number of qualitative characteristics which distinguish the elements. Further, these lastly-named elements possess properties which determine the greater or less stability of compounds; these, again, are chemical properties. It is in this manner that some elements can unite with all the others in compounds capable of being decomposed with a relative facility, while we cannot obtain analogous decompositions in the corresponding compounds of other elements. Not being susceptible of exact measurement, the above-mentioned chemical properties can hardly serve to generalise chemical knowledge; they alone cannot serve as a basis for theoretical considerations. However, these properties should not be altogether neglected, as they explain a great number of chemical phenomena. It is known that Berzelius and other chemists considered these properties as being among the principal characteristics of elements, and that it is on them that the electro-chemical system was based.

As a general rule when we study the properties of elements, bearing in mind practical conclusions and chemical previsions, it is necessary to give equal attention to the general properties of the other bodies of the group, and to the individual properties of the given element in that group; it is only after such comparative studies, and laying stress on an accurately measurable property, that we can generalise the properties of an element. The atomic weight furnishes us now, and will long continue to furnish us, with a property of this nature; for our conception of the atomic weight has acquired an indestructible solidity, above all latterly, since the use of Avogadro's and Ampère's law: thanks to the efforts of Laurent, Gerhardt, Regnault, Rose, and Cannizzaro, one can even state boldly that the notion of the atomic weight (considered as the smallest part of an element contained in a molecule of its compounds) will remain without change, whatever may be the modifications that the philosophical ideas of chemists may undergo. The expression atomic weight* implies, it is true, the hypothesis of the atomic structure of bodies; but, then, we are not here discussing denomination, but a conventional idea. It seems that the best method of extending our chemical knowledge would be to elaborate the correlations between the proportions of elements and their atomic weights. It is thus that we should obtain the most natural and most fruitful results in the extension of the study of elements. To determine this dependence seems to me to be one of the principal tasks of future chemists; for this problem has the same philosophical importance as the study of the conditions of isomerism has. In the present memoir I shall try and show the already mentioned relation between the atomic weights of elements and their other properties, particularly the faculty of giving different forms of combination.

This last faculty has already been carefully experimented on; a still more precise expression has recently

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* By replacing the expression of *atomic weight* by that of *elementary weight*, I think we should, in the case of elements, avoid the conception of atoms.

been found for it, in the theory relative to the limits of chemical combinations, to the atomicity of elements, and to the manner of attachment of atoms in the molecules. It is known that Dalton called combinations in multiple proportions the mode of combination of an ideal element, R, with other elements (of the form RX, RX_2, RX_3, &c.); Gerhardt called them types; they are now used for fixing the atomicity of elements.

The incompleteness which exists in the theory now accepted, with regard to the atomicity of elements, arises from the fact that the opinions of chemists do not coincide in respect to elements such as Na, Cl, S, N, P, Ag; some consider the atomicity as an invariable property of atoms, while others affirm the contrary. The uncertainty in the ideas on atomicity come principally from the novelty of their introduction into Science, and from this—that they include the hypothesis of the union of elements by parts of their affinity. It also arises, according to my idea, from the fact that we only study the forms of combination, without comparing these forms with the other properties of the elements. The gaps which I have just pointed out in the theory of combinations—gaps produced by the doctrine actually accepted on the subject of the atomicity of elements—are at their widest, as I shall point out further on, if the study of the principal properties of elements is based on the atomic weights.

Since the year 1868, the year in which the first part of my work "Principles of Chemistry" appeared, in the Russian language, I have been endeavouring to solve this problem. In this paper I take the liberty of making known the results obtained up to the present time in my researches in that direction.* The formation of natural groups, such as the haloids, the metals of the alkalies and alkaline earths, the bodies analogous to sulphur, to nitrogen, &c., furnished me with the first opportunity of comparing the different properties of the elements with their atomic weights. In the beginning we only arranged in groups the elements which resemble one another in several respects, but later on several experimentalists—notably Gladstone, Cooke, Pettenkoffer, Kremers, Dumas, Lenssen, Odling, &c.—observed that the atomic weights of the different members of these groups had a simple and regular relation to each other. The discovery of these relations led to the comparison of the members of different groups with the homologous series, and, later on, to the conception, in a chemico-mechanical manner, of the complex nature of atoms, which has been held as reasonable by the greater number of chemists, but up to the present time it has not received any definite name.

All the relations observed between the atomic weights of elements have not yet led to any logical conclusion or chemical prevision, on account of the gaps in them. This may be the reason why they have not acquired the right of being generally recognised in Science.

First. Nobody that I know of has, up to the present, prepared any comparative table of the natural groups, and the observed relations between the different members of groups have remained without any connection or explanation. Concerning this subject, in 1859, Strecker rightly said,† "It is hardly possible that the relations noticed between the atomic weights of elements which resemble each other in their chemical properties should be purely accidental. However, we must leave to future research the discovery of the 'regular' relations which are betrayed in these numbers."

Secondly. Only small variations in the magnitude of the atomic weights of some analogous elements (Mn, Fe, Co, and Ni,—Pd, Rh, Ru,—Pt, Os, Ir) have been observed. Therefore we were only authorised in saying that the analogy of elements was connected either by approximate agreement or by the increasing amount of their atomic weights.

Thirdly. Nobody has established any theory of mutual comparison between the atomic weights of unlike elements, although it is precisely in connection with these unlike elements that a regular dependence should be pointed out between the properties and the modifications of the atomic weights. The facts published up to now, being too isolated, could not cause any progress in the philosophical development of chemistry; however, they contain the germs of important additions to chemical science, especially as concerns the nature, to us mysterious, of elements.

In the term *periodic law* I designate the reciprocal relations between the properties and the atomic weights of elements. Later on I shall develop the relations which are applicable to all the elements: they are shown in the form of a periodic function.

(To be continued.)

ON THE VOLATILITY OF PLATINUM IN CHLORINE GAS AT HIGH TEMPERATURES.*

By SEELHEIM, of Utrecht.

Some years ago the author made the curious observation that, when platinum foil is kept at a red heat in dry chlorine gas, the metal gradually volatilises, and in a colder part of tube gets re-deposited as a sublimate, consisting of measurable *crystals* of the regular system. The crystalline nature of the sublimate proves that the metal must have travelled through the tube as a *vapour.* In order, however, to make quite sure of this important result, the author, quite lately, repeated the experiment in a modified form, consisting in this, that he heated a quantity of platinous chloride in a porcelain flask to bright redness. The flask was allowed to cool and then cautiously broken up, when the metallic platinum due from the chloride was found, not at the bottom of the flask, but somewhere higher up at the sides, in the form of a crystalline sublimate. This, the author says, confirms what was observed some time ago by Troost and Hautefeuille, who found that platinous chloride, when heated to 1400° C. in a porcelain flask and allowed to cool, suddenly gives a deposit of $PtCl_2$, while when cooled down gradually it yields only Cl_2 and metallic platinum.

The volatilisation of the platinum must be owing to a chemical cause. We must assume that the metal, when heated in chlorine gas, passes, at least, temporarily, into a volatile chloride, which, *at lower temperatures*, breaks up again into chlorine gas and metallic platinum. If this chloride is $PtCl_2$, and $PtCl_2 = 1$ molecule, its vapour should occupy the same volume as the "Cl_2" contained in it, and consequently Victor Meyer's experiments prove, as before, that "Cl_2" at high temperatures dissociates into two or more molecules. But it is more natural to assume that the $PtCl_2$ vapour has only a transitory existence, being continually formed and re-decomposed into Pt vapour and chlorine. At any rate, Victor Meyer's results do not prove that chlorine gas (at 1500° or so) undergoes dissociation, because what he operated upon was not pure chlorine but chlorine contaminated with volatilised platinum.

So far Seelheim. In my own opinion the most natural interpretation of Seelheim's *and* Meyer's results is to assume that $2(Pt+Cl_2)$, produced by the decomposition at a *dull* red heat of $2PtCl_2$ at higher temperatures, *associate* into $2PtCl+Cl_2=6$ vols. (*i.e.*, 6 times the volume of $\frac{1}{2}H_2$) $=\frac{3}{2}$ times the volume the $2Cl_2$ present at the lower temperature. Or else we may assume that the atomic weight of platinum is $pt=\frac{1}{2}Pt$, and that, what on starting was $2pt_2Cl_2$ (solid), at higher temperatures got transmitted thus:—

---

* In relation to some historical and polemical observations on this question, see the *Berichte der Deutschen Chemischen Gesellschaft*, 1871, p. 348.

† "Theorieen und Experimente zur Bestimmung der Atom gewichte der Elemente," p. 146.

* A condensed translation of an article in the last number of the *Berichte der Deutschen Chemischen Gesellschaft.* Communicated by Prof. Dittmar.

$$\begin{array}{lccc} & 2pt_2Cl_2 = & pt_4+2Cl_2 = & 2ptCl+pt_2Cl_2. \\ & \text{Ord. temp.} & 500^\circ & 1500^\circ \\ \text{Vol.} = & 0 & 0+4 & 4+2 \\ \text{or—} & 0 & 4 & 6 \end{array}$$

Meyer's discovery, then, appears to be a mistake, but it is one of those mistakes that could only have been committed by a great experimenter like him.

W. D.

Anderson's College, Glasgow, Nov. 17, 1879.

ON THE NASCENT STATE OF BODIES.

By Dr. T. TOMMASI.

IN a recent number of the CHEMICAL NEWS (vol. xl., p. 184) Dr. Phipson observes that it is not logical to found an entire system on a single fact. In this he is perfectly right, and I entirely agree with him. I would, however, remind him that my thermic theory of nascent hydrogen does not rest on a single fact but on many. For more than two years I have been engaged in ascertaining whether the reductive properties peculiar to hydrogen when it comes out of a combination are due to an allotropic state of hydrogen, such as the nascent state, or to ordinary hydrogen in different thermic conditions. I have studied most of the reductions effected by hydrogen, and generally attributed to a nascent state such as—

Reduction of silver chloride, bromide, and iodide.
,, ,, chloric acid and chlorates.
,, ,, potassium perchlorate.
,, ,, ferric chloride.
,, ,, nitrates.
,, ,, chloral.

The following are the results I obtained:—

(1.) Silver chloride in suspension in dilute sulphuric acid was treated with sodium amalgam. The experiment, which lasted forty minutes, was made in the dark. The silver chloride remained perfectly white, and consequently had undergone *no reduction*, and the liquid separated from the silver chloride contained no trace of sodium chloride. It was the same with silver bromide and iodide. It follows, moreover, that nascent hydrogen ($Zn+SO_4H_2+Aq$) does not reduce silver chloride unless the chloride is in contact with zinc. This reduction, then, can only be attributed to the action of the zinc, and not to that of hydrogen. On the other hand, an electric current will decompose silver chloride in suspension in dilute sulphuric acid. How are we to explain the fact that silver chloride which resists the action of nascent hydrogen resulting from the decomposition of water by sodium amalgam can be reduced by hydrogen equally nascent, but which results from the decomposition of water by the battery?

(2.) A solution of potassic chlorate was acidulated with sulphuric acid, and then divided into two parts, one of which was treated with zinc, the other with sodium amalgam. The reaction was stopped at the same time, when there was still some sodium amalgam and some zinc, and before the sulphuric acid was completely neutralised. The two solutions were filtered, and silver nitrate added. The solution which had been treated with zinc gave rise to a very abundant precipitate of silver chloride, whilst the other, which had been treated with sodium amalgam, remained perfectly limpid. Chloric acid, sodium, barium, copper, and mercury chlorates undergo no reduction by sodium amalgam when in neutral, alkaline, or acid solution. The hydrogen proceeding from the electrolysis of water does not easily deoxidise potassium chlorate.

(3.) M. Guetta, in a work on the reduction of nitrates, has arrived at conclusions precisely similar to those I have arrived at with regard to chlorates. I had foreseen most of the results obtained by M. Guetta, and was glad to see them confirmed by his experiments.

(4.) M. Papasogli has recently discovered that a solution of nickel, to which potash and potassium cyanide were added, acquires, by the action of the zinc, a beautiful red tint, whilst at the same time hydrogen is set free. If magnesium takes the place of zinc in this experiment—or, better still, if the magnesium-platina couple is used—the evolution of hydrogen is always observed, but the colouration no longer takes place. On the other hand, the double cyanide of potassium and of electrolysed nickel is coloured red at the negative pole. In these cases the red compound is either produced by the metal or nascent hydrogen. In the former case the red tinge would not be produced by the action of hydrogen resulting from the decomposition of water by the battery, and in the second case it would manifest itself, because the hydrogen set free by the magnesium-platina couple is equally nascent as that developed by the zinc or by the electric current.

(5.) M. Sergius Kern (CHEMICAL NEWS, vol. xxxiii., p. 112) observes that magnesium is rapidly dissolved by ferric chloride, ferric hydrate being formed. This paper was afterwards reproduced in the *Bulletin de la Société Chimique de Paris*, vol. xxvi., p. 338, but the editor of that journal remarks that it does not appear probable that ferric hydrate is produced when hydrogen is evolved unless air is admitted. I repeated that experiment, excluding the air, and using water that had first been boiled; but the results that I obtained were exactly identical with those of M. Sergius Kern. It is the same when sodium amalgam is substituted for magnesium.

(6.) According to Mr. C. Stahlschmidt (*Pogg. Annalen*, vol. cxxviii., p. 416) it would seem that the nascent hydrogen which results from the decomposition of water by powdered zinc at the ordinary temperature changes potassium nitrate into nitrite, red cyanide into yellow cyanide, reduces indigo and the iodates, but, most remarkably, *does not reduce the nitrates.*

(7.) Prof. De Wilde, of Brussels, has observed that whilst sodium amalgam reduced potassium bromate, it had no action on potassium chlorate. How, then, without recurring to my theory, would Dr. Phipson explain the fact that potassium perchlorate, which resists the action of sixteen sources of nascent hydrogen, can be reduced by sodium bisulphite? And why does the nascent hydrogen proceeding from the action of zinc on dilute sulphuric acid reduce the potassium chlorate while it has no action on the perchlorate? In the last two cases is it not always in the nascent state that the hydrogen is set free? and is not the medium in which it is produced the same? If, then, the properties of nascent hydrogen were inherent to that special state of the gas the same reactions ought always to be obtained; but the few experiments I have just quoted, and many others which I pass over in silence, prove, on the contrary, that the reductive power of nascent hydrogen varies according to the chemical reaction which produces it. And if this gas in the nascent state possesses greater affinity than in the natural state, it is solely due to the fact *that the hydrogen the moment it issues from a combination is found to be accompanied by the whole quantity of heat produced during the setting free of the hydrogen.* Consequently, nascent hydrogen is nothing else than *ordinary hydrogen in thermic conditions or, speaking generally, in different physieal conditions.* To my mind, the expression nascent hydrogen is synonymous with hydrogen + calories. In fact, all the reactions produced with nascent hydrogen can be obtained quite as well with ordinary hydrogen and a high temperature; and the differences observed between the hydrogen resulting from different chemical reactions are simply due to the fact that these reactions do not develop the same quantity of calories.

Now is any further proof wished for that nascent hydrogen is nothing but H + cal. I take, for example, the action of hydrogen on sulphur. This body, as everybody knows, does not combine at the ordinary temperature with hydrogen, but the reaction takes place if that gas is in what is called a nascent state. On the other hand, M. Janario, by causing a current of hydrogen to pass over the melted sulphur has been able to determine a reaction between these two bodies. Is it not the same cause which lead to the formation of sulphuretted hydrogen? In these two reactions the sulphur and hydrogen require a certain quantity of heat in order to combine; only in the first case that heat is provided by the combustion of lighting-gas, and in the second case by a chemical reaction. The physical conditions alone are changed, the hydrogen remains the same.

Dr. Phipson says that in 1858 he presented to the Society of Sciences at Haarlem, a memoir, entitled "Catalytic Force, or Study on the Phenomena of Contact," and in which he propounded a theory to explain the nascent state of bodies. I deeply regret that I was unacquainted with Dr. Phipson's interesting memoir, otherwise I should certainly have spoken of it in my notes. I must, however, say that the Chemical Dictionaries of Watts, Wurtz, and Selmi (on the article "Nascent Hydrogen"), and the principal chemical treatises do not mention in any way the experiments or theories put forth by Dr. Phipson; nor do they quote any chemist who took up the question before myself. It is right to say that M. Ste.-Claire Deville announced the existence of hydrogen in the nascent state, but he has not explained why that gas has greater affinity in the nascent than in the ordinary state.

I hope that when Dr. Phipson has read this paper he may perhaps accept my thermic theory of the nascent state of hydrogen. If, on the contrary, he fails to do so, I shall always be very happy to reply to any objection he may raise on the subject.

COMPARATIVE RESULTS OBTAINED WITH PREVIOUS ELECTRICAL OZONISERS, WITH DESCRIPTION OF A MODIFIED AND POWERFUL FORM.

By ALBERT R. LEEDS, Ph.D.

I.

In pursuing this enquiry, two objects were kept prominently in view:—1st. To obtain ozone by a method which could be relied upon at all times, and which would not only be independent of changes in temperature, humidity, &c., but require little or no supervision from the experimenter after once being set into operation. 2nd. To be able both to ozonise to a maximum the air or oxygen employed, and to employ large volumes of the ozonised gas.

The considerations summarised under the first head, finally caused the abandonment of a large Holtz machine, with which the experiments had been originally instituted. For, granting that by the use of suitable precautions the disturbing influences of atmospheric variations are eliminated, there still remains the necessity of a considerable amount of mechanical power to drive the machine.

With regard to the second point, we were assisted chiefly by Dr. Siemens's theoretical discussion of the principles involved in the construction of the induction tube which bears his name. In the experiments of Von Babo and Claus, with an ozoniser devised by the first-named, a very small volume of oxygen confined within the apparatus was subjected for many hours to the action of electricity generated by a powerful coil.[*] The maximum degree of ozonation was reached under these circumstances when the confined gas ceased to contract, and this maximum in various trials corresponded to 3·1 to 5·74 per cent of ozone. Brodie employed a Siemens tube, the interior and exterior surfaces being cooled to 0° or even −10° by ice or a mixture of ice and salt.[†] The highest percentage of ozone obtained in this manner was 6·5 per cent. A very powerful coil was employed, the passage of the gas in each experiment occupying about thirty minutes, and the volume of the oxygen varying from about 100 c.c. to less than 300 c.c. Experiments were made with the view of ascertaining the effect of repeated electrisation of the gas on passing it several times through the induction tube. It was found that on its fourth or fifth passage it contained no higher percentage of ozone than it did at the end of the first. These experiments agreed, therefore, with those of Von Babo and Claus, in so far as they likewise appeared to show that there was a fixed limit prescribed by the conditions of the experiment, beyond which the ozonation cannot pass, but differed in the respect that this limit was reached at once, while in those of Von Babo and Claus it was not attained until after powerful electrisation for many hours.

But the object in the present enquiry was not to ozonise to a maximum a small volume of confined gas with the view of studying the properties of the gas itself. It was rather to ozonise to a maximum a *current* of air or oxygen, with a view of studying the reactions produced by it in the various substances with which it was brought in contact. It was also desirable, if possible, to employ a large volume of oxygen, and to keep it flowing rapidly, so that the total amount of ozone produced might be considerable. With these ends in view, the various forms of ozonisers hitherto proposed were tried, and failed to give, in our hands, the character of results sought for, until eventually, after many modifications, a development of the Siemens induction tube was arrived at, which has proven satisfactory.

After discarding the Holtz machine an induction coil of ten Bunsen elements (set up as two large cells) was employed. The axis of the wheel which operated the hammer used in making and breaking connections was also the axis of a pulley, connected by a belt with another pulley, run by a small electro-magnetic machine. This latter was driven by two additional Bunsen cells, and the speed so regulated that about 60 sparks would pass between the terminals of the coil per minute. As thus arranged, the coil was used to supply the electricity employed in making the trials on the various ozonisers employed. The results given are the best which we could obtain, and as such are put on record, without attempting to explain why, in some instances, they are so low.

Wright's Ozoniser.[*]

The first tried was that of Prof. Wright, who, however, had made use in his own experiments of a Holtz machine as the source of electricity. The original description was followed closely. A straight glass tube, 20 c.m. in length and 2·5 c.m. in diameter, was closed at each end with paraffined corks, through the axis of which stout copper wires were passed, one carrying a terminal in the form of a ball, the other a terminal disc. Inlet and exit tubes were also let into the corks eccentrically to provide for the flow of gas.

A very slow stream of perfectly dry oxygen was made to flow through the apparatus. The maximum result was 0·76 m.grm. of ozone per litre. The oxygen used contained about 2 per cent of nitrogen. It was dried in this and the subsequent experiments by passage through a series of sulphuric acid dryers.[†]

Houzeau's Ozoniser.

According to M. Houzeau's description (*Compt. Rendus*, lxxiv., 256), this is constructed of a straight tube, in the interior of which is a wire of copper, lead, or, better, of platinum, 40 to 60 c.m. long, passing through the upper

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[*] "Researches on the Constitution of Ozone," *Am. der Chem. und Pharm.*, cxl., p. 248.

[†] Sir B. C. Brodie "On the Action of Electricity on Gases," *Phil. Trans.*, 1872, p. 435.

[*] *Am. Journ. Sci.*, [3], iv., 29.

[†] Note.—Gianetti and Volta (*Berichte der Deutschen Chemischen Gesellschaft*, vii., p. 1462) with a similar apparatus, employing the Holtz machine, obtained 15 m.grm. of ozone per litre. Later (*Ibidem*, ix., p. 84) they employed a form of Siemens induction tube, with the inner and outer tubes 2 c m. and 2½ c.m. respectively, in connection with a Holtz machine. They found that the slower the stream and the lower the temperature, the larger the percentage. Between 5° and 10°, ½ litre of oxygen flowing per hour, they obtained 40 m.grms. ozone per litre. On substituting a Ruhmkorff coil, they obtained, under like circumstances, only one-third this amount.

side. A wire is wrapped around the exterior, which is a little longer than the interior wire, and connects with the other pole of the induction coil. With such an apparatus, and with a coil giving 2 to 3 c.m. sparks, Houzeau states that he readily obtained 60 to 120 m.grms. of ozone per litre of ozonised air, according as the experiment was performed at +15° or −30°. In one case he obtained 180 m.grms., and expressed the opinion that the complete conversion of oxygen into ozone was to be regarded as possible.

Two ozonisers of this form were made. The first, of a tube 55 c.m. long and 15 m.m. diameter. A spiral of platinum wire, 90 c.m. long, coiled around the middle portion of the exterior of the tube, formed one pole; a straight platinum wire passing along the axis of the interior of the tube, the other.

Results.—Oxygen used, a slow current flowing, 3·25 litres; ozone obtained, 16·07 m.grms., or 4·95 m.grms. per litre. Temperature, 20°. Second trial.—Oxygen used, 5·125 litres; ozone obtained, 19·85 m.grms., or 3·9 m.grms. per litre. Temp., 21°.

These results being highly disappointing, a more elaborate ozoniser of this class was constructed. The outside tube was 60 c.m. long and 18 m.m. diameter. Around the middle portion of this exterior tube, for a length of 40 c.m., was coiled a platinum spiral 177 c.m. long, with 32 turns. In the axis of this tube another glass tube 6 m.m. in diameter was placed, with a similar platinum spiral, but having 70 turns, and coiled in the opposite direction. The inner tube was kept concentric with the outer by two rings of glass beads.

Results.—Placed in a mixture of ice and salt. Oxygen used, 4½ litres; ozone obtained, 19·03 m.grms., or 4·6 m.grms. per litre. No better result on second trial. Repeated.—Temp., 22°; spark-length, 30 m.m. Oxygen used, 1·6 litres; ozone obtained, 3·78 m.grms., or 2·4 m.grms. per litre.

Since, in these and subsequent trials, Houzeau's ozoniser, in my hands, yielded equally unsatisfactory results, its use was abandoned.

BOILLOT'S OZONISER.

Its peculiar features are—1st. The use of gas-carbon as the material constituting the two poles; 2nd. The ozonised oxygen is allowed to flow through, and in contact with, one of these poles, instead of isolating the gas-carbon in a glass tube. The apparatus was constructed so as to embody the ideas of its author, as far as we understood them.*

The oxygen was conveyed through a glass tube, 60 c.m. long and 15 m.m. in diameter. This was closed with paraffined corks at both ends, through which smaller glass tubes were passed for inlet and outflow of gas. It was filled with coarse fragments of gas-carbon, each about the size of a pea. These were connected with one pole by a copper wire passing through the cork. The middle of this tube was surrounded by another tube, 19 m.m. in diameter, the space between them being filled with pulverised gas-carbon, and connected by a copper wire with the other pole.

Results.—Length of spark, 60 m.m. at beginning, 50 m.m. at close of experiment; temp., 20°; time, two hours; amount of oxygen used, 4½ litres; of ozone obtained, 11·91 m.grms. This is equivalent to 2·77 m.grms., or 1·29 c.c. per litre.

VON BABO'S OZONISER.†

The instrument of this description, as constructed by ourselves, was made as follows. 14 small thin tubes, 2·5 m.m. wide and 900 m.m. long, were joined together two by two, and thrust into a large tube, 21 m.m. inside diameter and 975 m.m. long. The thin tubes were kept apart by means of little pieces of tubing, about 10 m.m. long and just large enough to fit over the other tubes. In each tube was placed a copper wire running through nearly its entire length, and connected with a platinum wire, and then they were sealed by the gas flame. The tubes in couples were so arranged that the platinum wire of one projected from one end of the large tube, and the platinum wire of the other projected from the other end. The bundles of wires were connected at each end with copper wires going off to the coil, the junction being made outside of the enveloping tube, which was provided with inlets and outlets for the gas.

Result.—Spark-length, 70 m.m.; time, thirty-five minutes. Oxygen used, 1 litre; ozone obtained, 9·15 m.grms. In the dark it was found that the discharge was not altogether silent, a few points of light being visible.

Thinking that a better result might be obtained by spreading the charge over a lesser extent, another ozoniser of this pattern was fitted up with only 5 pairs of tubes, all the other arrangements being the same.

Result.—Time, seventy minutes. Oxygen used, 1 litre; ozone obtained, 2·5 m.grms. Minute points of light were also noticeable in the dark along the sides of some o these tubes.

After these trials, the attempt to employ ozonisers of Von Babo's form was abandoned.

SIEMENS'S OZONISER.

The original description of this ozoniser, which was designed and constructed according to certain theoretical conceptions by W. Siemens (*Ann. der Phys. und Chem.*, cii., 120) more than twenty years ago, is as follows:—It is made of two tubes of the thinnest suitable glass. One of them, which is closed and the narrower of the two, is set inside the other in such a way that the annular space between them is of uniform width throughout. The outer is melted to the inner tube at one end, and at the other is narrowed down into an exit tube. The inlet tube is joined to the other end of the outer tube. The inner and outer surfaces of the glass tubes are coated with metallic foil and oppositely electrified.

With the objects in view, which were set forth at the beginning of this article, a very large number of ozonisers of this description were made, and the successive improvements, as shown by the increase in the amount of ozone obtained, rapidly led to the modification, which was finally adopted.

The first was constructed of a tube 50 c.m. in length and 35 m.m. in diameter, narrowed down at each end so as to unite with a straight tube passing through its middle, 17 m.m. in diameter. It is not necessary to fuse the tubes, so as to close the annular space, a joint of sealing-wax remaining unaffected. The inside of this second tube was covered with tin-foil, and formed one pole; the exterior of the outer tube was covered with 378 c.m. of tin-foil, and constituted the outer pole. The lateral inlet and exit tubes for the passage of the gas were closed with small wash-bottles made of test-tubes, and containing sulphuric acid. This simple arrangement prevents backward diffusion of the ozone, and consequent destruction of the rubber connections.

Result.—Oxygen employed, 1 litre; ozone obtained, 7·18 m.grms.

After the experiments given in the present article were concluded, a Siemens ozoniser of the pattern known as Geissler's, was received from Bonn. The interior tube was 18 m.m., the exterior tube 27 m.m. in diameter, and the exterior surface of the latter over a length of 30 c.m. was coated with foil; about the same length of foil was contained in the inner tube. The outer tube was again surrounded by a final enveloping glass tube. All the joints and connections in this difficult piece of glass-blowing were of glass. In our own trials we were compelled the make the joints of sealing-wax. As this, however, lowered all the quantities found, their relative values and significance would still remain.

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* *Comptes Rendus*, lxxv., 214 and 1712; CHEMICAL NEWS, xxvi., 312; *Journ. Chemical Society*, N.S., x., 879.

† "Volumetric Relations of Ozone," *Ann. der Chem. und Pharm.*, Suppl. ii., p. 297.

Result.—Spark-length, 31 m.m.; time, forty minutes. Oxygen used, 1 litre; ozone obtained, 28·16 m.grms.

A series of experiments was now instituted to determine the influence of the extent of electrified surface, its separating distance, duration of exposure of the current of oxygen to the silent discharge, and of the spark-length upon the amount of ozone obtained. With these objects we employed:—

I. Ozoniser of one metre in length, of which 850 m.m. were covered with tin-foil. Diameter of outer tube, 25 m m.; width of annular space intervening, 1 m.m. Both inside and outside tubes of very thin glass.

Result.—Oxygen employed, 1 litre; ozone obtained, 23·65 m.grms. Spark-length, 85 m.m.; temp., 22°; duration of experiment, *ten minutes.*

II. Length of tube, 1 metre; length of exterior of outer tube covered by tin-foil, 925 m.m.; diameter of outside tube, 47 m.m.; diameter of inside tube, 25 m.m.; width of the annular space intervening, 11 m.m.; walls of the glass tubes thicker than the preceding.

Result.—Oxygen employed, 1 litre; ozone obtained, 5·8 m.grms.; time, ten minutes; temp., 22°; spark-length, 60 m.m.

Therefore, in the construction of tubes subsequently made, glass tubes as thin as could be obtained, and with as small an annular space between them as possible, were employed.

III. Using the same (II.) ozoniser, an experiment was made to determine the effect of prolonged exposure to the silent discharge upon the degree of ozonation. After filling with oxygen, the coil was thrown into operation for fifteen minutes, and then, the coil being still active, a current started, and allowed to flow until 1 litre of oxygen had passed through the ozoniser, the time required being ten minutes.

Result.—Oxygen employed, 1 litre; ozone obtained, 10·2 m.grms.; time, 15 + 10 = 25 minutes; temp., 22°, spark-length, 55 m.m.

IV. A similar experiment was tried with the first (I.) ozoniser.

Result.—Oxygen employed, 1 litre; ozone obtained, 21·54 m.grms.; time, 15 + 10 = 25 minutes; temp., 22°; spark-length, 55 m.m.

In this experiment a lower result in the total amount of ozone obtained is very noticeable as compared with I., in which, however, the spark-length was 85 m.m.

V. Using, therefore, the same ozoniser (I.) with the spark-length of 55 m.m., the experiment was repeated without setting the coil into action prior to beginning of the flow.

Result.—Oxygen employed, 1 litre; ozone obtained, 14·93 m.grms.; time, ten minutes; temp., 22°; spark-length, 55 m.m.

The foregoing experiments point out the proper directions in which to modify the apparatus in order, under given circumstances, to bring the degree of ozonation to a maximum:—

(*a.*) To diminish the distance between the electrified surfaces, both by diminishing the thickness of the glass and by lessening the annular space between the two tubes.

(*b.*) By prolonging the interval during which the oxygen is subjected to the silent discharge. There are evidently two ways of doing this—either by lessening the rate of flow, or, the intensity of static charge being preserved the same upon each unit of electrified surface, by increasing the length of the tubes. The latter method was adopted, since the principal object in view was that of obtaining the largest possible total quantity of ozone.

(*c.*) Along with the increase in the length of the tubes, to raise correspondingly the length and number of the sparks (within the limits of the silent discharge).

(*d.*) Since no notable elevation of temperature was perceived, in the case of large tubes operated in this manner, it was deemed important not to complicate the apparatus by arrangements for depressing the temperature.

Since considerable time was required to line the inside of the inner tubes with tin-foil, some trials were made to learn whether a simpler arrangement would answer.

VI. The outside of the inner tube, this time of heavy glass, was coated with tin-foil, and the outside of the outer tube with the same, the length covered by the tin-foil being 900 m.m., and the annular space between the tubes 1 m.m.

Result.—Spark-length, 62 m.m.; time, 10 min.; temp., 21°; oxygen used, 1 litre; ozone obtained, 1·89.

VII. The tin-foil was transferred from the outside to the inside of the inner tube, everything else remaining the same.

Result.—Oxygen used, 1 litre; ozone obtained, 10·58 m.grms.

These trials demonstrated the importance of separating the electrified surfaces by glass walls. The tin was not noticeably affected, and the diminution of ozonation was probably due to the loss of tension consequent on removing one of the insulating surfaces.

VIII. To study the effect of prolonging the interval during which a certain volume of oxygen was subjected to ozonation, the ozoniser used in VII. was charged for fifteen minutes, the gas not flowing. The volume of oxygen contained in the annular space and ozonised in this manner was 70 c.c.

Result.—Spark-length, 55 m.m.; time, 15 minutes; oxygen used, 70 c.c.; ozone obtained, 2·31 m.grms., corresponding to 33 m.grms. per litre.

Since an increase in the length of the tube would also have the effect of prolonging the duration of ozonation, the foregoing experiment suggested those which follow, and ultimately led to a satisfactory solution of the problem in hand.

IX. A thin glass tube, 25 m.m. wide and 1 metre long, was coated with tin-foil over 815 m.m. of its outside surface. An inner tube was similarly coated on the inside over 815 m.m. Its inner coating was connected with copper-wire with one pole. Both ends of each tube were sealed with paraffin corks, the outer tube enclosing the inner, and the inner separated by glass rings by an annular interval of 1 m.m. from the outer. A duplicate ozonising tube was prepared, and the outer surfaces of the two connected together and with one pole of the coil, and likewise their inner surfaces with the other pole.

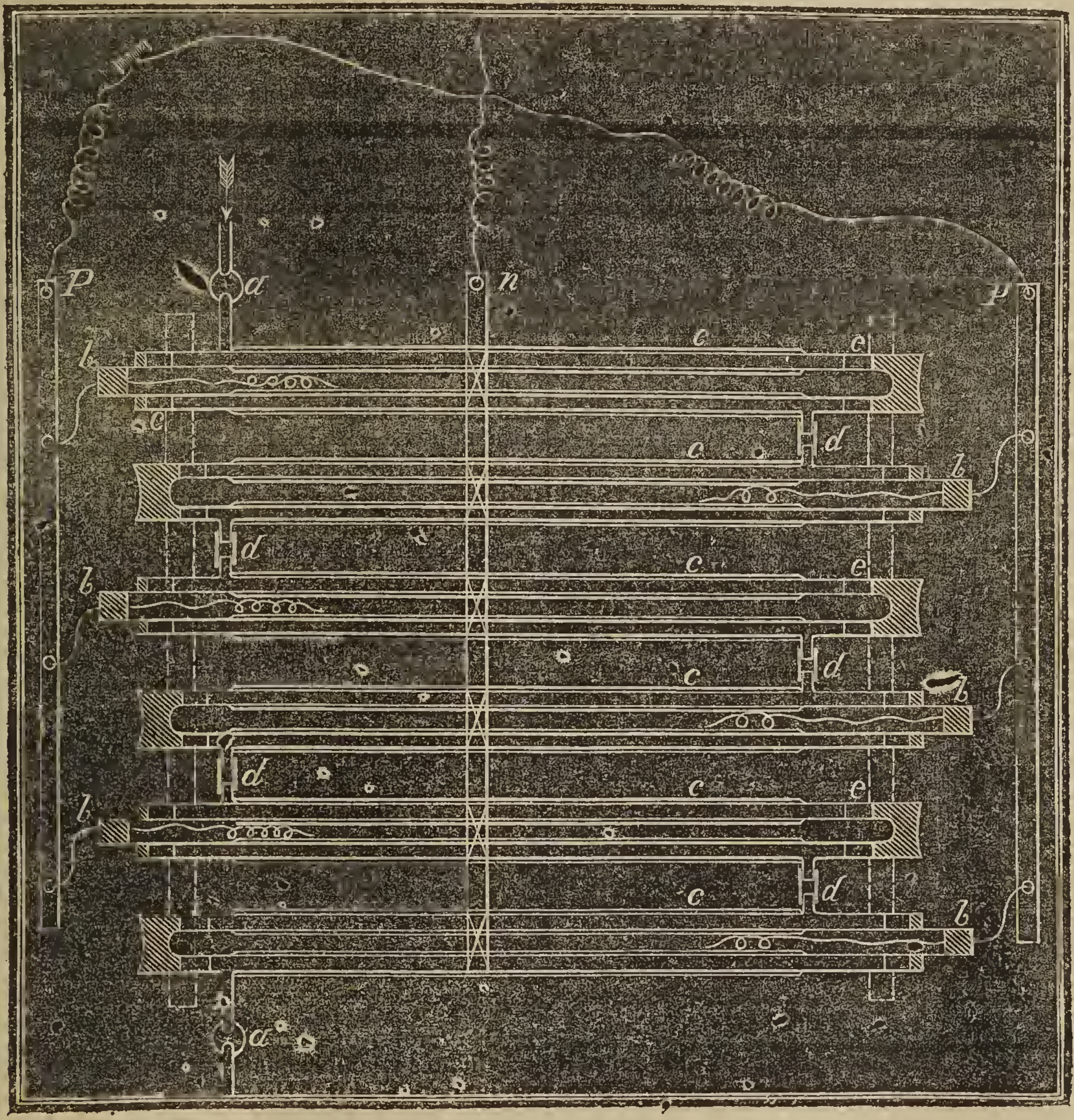
Results.—Spark length, 50 m.m.: temp. 21·5° C.; time, 30 mins.; oxygen used, 1 litre; ozone obtained, 52·54 m.grms.

Repeated, but the ozoniser charged for 5 minutes before beginning the flow of oxygen; ozone obtained, 57·83 m.grms.

Repeated, the charging being begun 15 minutes before flow; ozone obtained, 71·82 m.grms.

Finding, as the result of other variations in the lengths and proportions of the tube, the conclusions arrived at above were confirmed, the form of ozoniser as finally used and adopted was constructed, and will be found figured in the text. Each induction-tube is a modified Siemens tube, and may be called a Siemens's element. Six of these elements are connected together and supported on a frame, constituting what we may term an ozonising battery. One of these frames is fitted on above another, the end elements of the two batteries being suitably connected, and in this way, by repetition of similar parts, an ozonising tube of as great length as desired can be made and handled without inconvenience. Or the electrical charge can be divided between several ozonising batteries and the supply of oxygen as well, so that a number of currents of ozonised gas can be used at the same time.

Each element is made of a tube of thin hard glass, 60 c.m. long and 21 m.m. inside diameter, with the inlet and outlet tubes 6 c.m. from each extremity. The space between these two latter tubes is coated with tin-foil. The inside tube is a little longer, one end being rounded; the other, after the interior has been coated with tin-foil, is closed with a dry cork, through which the copper connecting wire passes. The space between the rounded end of the inner tube and the outer tube is nearly filled by a ring of glass cut from a tube of suitable bore, and the space closed by dipping in molten sealing-wax. In coupling the elements together, the exit-tube of the first is joined to the inlet tube of the second by a wrapping of strips of muslin, which are bound by flower-wire, and made gas-tight by a coating of molten paraffin applied with a brush. The first inlet tube of a battery and the last exit tube are made parts of small sulphuric acid wash-bottles, by means of which the rubber or kerite connections with the other parts of the apparatus are protected from backward diffusion of the ozonised gas on the one hand, and a convenient attachment is made upon the other.



Description.

a a, small sulphuric acid wash-bottles. *b b*, corks closed by melted sealing-wax. *c c*, outside coating of tin-foil. *d d*, connections of paraffined cotton-cloth. *e e*, rings of glass. *p p*, copper strips connecting with inner coating and one pole. *w*, copper strip fastened to all the outer coatings and the other pole.

Results.—With a battery of 3 elements—Time, 30 mins.; oxygen used, 1 litre; ozone obtained, 22·8 m.grms.

With a battery of 6 elements—Time, 30 mins.; oxygen used, 1 litre; ozone obtained, 51·74 m.grms.

Repeated, after an interval, but with same number of elements—Oxygen used, 1 litre; ozone obtained, 49·5 m.grms.

With two batteries, 12 elements in all—Spark-length, 45 m.m.; time, 30 mins.; temp. 24°; oxygen used, 1 litre; ozone obtained, 69·93 m.grms.

In this shape, the apparatus proving adequate to perform the work required, it was used almost daily for three months, the average yield of ozone, with the battery in good condition, being 72 m.grms. per litre, or about 5 per cent.

To obtain the best results with such a battery the following precautions should be observed:—(1) The connections at *d d* should preferably be ground, and the other joints be made by fusion. (2) The number of elements used should be proportioned to the strength of the coil, the maximum being obtained when the whole interior is luminous, but without sparks, in a darkened room. (3) The feeble inductorium should be replaced by one giving a large number as well as a great length of sparks. (4) The exterior foil should be covered with an outer enveloping tube of glass. (5) The temperature of the ozonising battery should be prevented from rising by placing it within a refrigerating chamber, and surrounding it by dry air kept at 0°.

Examination of Commercial Gums.—E. Masing.—The author compares the behaviour of the Arabian, Asiatic, American, and Australian gums with reagents, and concludes that the Arabic acid, present in all, occurs in modifications influenced by the presence of the mineral constituents.—*Arch. Pharm.*, xii., 216.

ACTION OF LIME ON SILICA IN MORTAR.

By W. B. ROBERTS, M.S.A.

Having found in the recent analysis of some specimens of old mortar from the walls of a building, erected about two hundred years ago, considerable traces of hydrated silica, it occurred to me that possibly the hardening or setting of mortar might be due to some chemical action occurring between the lime and the silica when these ingredients were mixed, whereby some proportion of the silica was caused to assume the gelatinous form; that this being then incorporated by the usual mixing process, subsequently solidified, binding the whole bulk with a hard network of silica. To test this, I obtained two good specimens, one from the exterior, and one from the centre of a wall which was two feet thick, for the purpose of making a careful analysis of each. In order to compare the results with those of some experiments presently to be described, I also examined a sample of mortar from a building of comparatively recent date.

Subjected to the mechanical test of a gradually increasing pressure, the two older samples proved about equal in hardness, while both of them were harder than the third. The samples taken for analysis were quite free from brick, and few of the grains of sand were of greater weight than about 1 grm.

The specimens were crushed fine in a steel mortar, and 200 grms. of each treated for twelve hours with sulphuric acid (sp. gr. 1·65); the temperature was then gradually raised, until the excess of acid was completely expelled; after cooling the residue was boiled up repeatedly with water; the insoluble residue gave the total silica—conveniently referred to as silica, silica free, and sand.

To find amount of soluble silica, the insoluble residue was boiled with a saturated solution of sodium carbonate for a considerable time; the liquid, after filtration, was treated with hydrochloric acid and evaporated to dryness in the usual way, and gave the amount of free and combined soluble silica in the mortar.* Then, to ascertain how much, if any, free hydrated silica, *i.e.*, silica which was or had been gelatinised, existed in the mortars, 200 grms. of each were treated with saturated solution of sodium carbonate exactly in the manner just described for separating the soluble silica from the sand. The percentage of previously gelatinised silica was confirmed by treatment with pure hydrofluoric acid. The other constituents were estimated by the ordinary methods. The following were the results obtained:—

	I. From Exterior of old Wall.	II. Interior of old Wall.	III. More recent Mortar. Exterior.
Sand	67·12	67·19	65·54
Combined silica.. ..	1·12	0·93	0·18
Free hydrated silica ..	0·68	0·40	0·09
	68·92	68·52	65·81
Calcium carbonate ..	25 05	28·04	31·84
Magnesium carbonate	0·68	0 60	0·09
Sodium carbonate ..	0·90	1·41	trace
Lime, originally as silicate	1·05	—	—
Soda	0·41	—	—
Calcium sulphate ..	0·49	0·43	0·19
Sodium chloride.. ..	0·17	0·14	0·08
Oxide of iron, alumina	0·02	0·02	0·01
Water, hygroscopic ..	2·09	1·02	1·78
	99·78	100·18	99·80
Carbonic anhydride ..	11·78	13·18	15·033

To find as far as possible whether the original lime had contained any calcium silicate—this being, as is well known, produced sometimes in comparatively large quantities during the burning of different limestones—as much of the lime as could be picked out free from sand by the aid of a lens was tested for free or combined soluble silica in the same way as the mortar. The results were:—

	I.	II.	III.
Soluble silica per cent ..	0·17	0·20	0·11

Further, to test whether, in a comparatively short time, the sand would be attacked by freshly slaked lime, 300 grms. of fine sharp sand, free from soluble silica, were placed in each of three bottles under the following conditions for six months, after which time analysis gave the results stated below:—

	Soluble Silica Per cent.
I. Mixed with 150 grms. pure lime, and sufficient water to make a thick paste, and prevented from absorbing CO_2 ..	0·09
II. Same as I., but with the addition of 2 grms. of mixed carbonate of soda and potash	0·17
III. Same as II. with occasional slow current of CO_2, besides constant access of atmospheric air	0·08

From the general results of the above analysis and experiments, I conclude that the accepted theory of the hardening of mortar, namely, that it is due to the absorption of carbonic acid, is unshaken.

In the cases of the experiments I. and II. the conditions have been very favourable for the action of the lime upon the silica, but its effects are manifestly too small to materially influence the hardness of the resulting mortars. However, samples I. and II. were harder than III., although I. contained much less CO_2 than III. My general conclusion may be summarised as follows:—

(1.) Practically no gelatinisation of silica occurs in the manufacture of mortar.

(2.) That under the ordinary conditions of access of atmospheric air the lime in mortars becomes gradually dehydrated, absorbs carbonic acid, and forms neutral carbonate.

(3.) That the absorption of carbonic acid is very slow.

(4.) A slight action takes place between the lime and the silica, though this appears to be too small to determine its nature.

(5.) That, although even the small proportion of dry silicates slightly increases the hardness of a mortar, the ordinarily sufficient hardness of mortar is obtained by simple dehydration and carbonation.

These conclusions appear to be confirmed by the fact that lime already containing a small proportion of carbonate is preferred to pure lime for making mortar.

University of London.—The following is a list of the candidates who have passed the recent Second B.Sc. Examination:—(*First Division*).—S. G. H. Barfield, private study; G. Brown, private study; G. J. Burns, private study; W. D. Halliburton, University College; S. L. Hart, St. John's College, Cambridge; R. S. Heath Trinity College, Cambridge; G. B. Hoffmeister, Gonville and Caius College, Cambridge; E. Hopkinson, Emmanuel College, Cambridge; A. H. S. Lucas, private study; J. G. Ridsdale, Guy's Hospital and private study; G. T. Smith, Modern School, Bedford; J. W. W. Waghorn, private study; T. W. Williams, University College and Royal School of Mines. (*Second Division*).—J. A. B. Bennett, Downing College, Cambridge; W. Fawcett, private tuition; J. J. Fletcher, B.A. Syd., Royal School of Mines and University College; S. J. Hickson, Downing College, Cambridge; W. Overend, University College and St. Bartholomew's Hospital; T. Purdie, University of Würzburg and private study; E. H. Rennie, M.A. Syd., St. Mary's Hospital and private study.

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* Thorpe, "Quantitative Analysis," p. 185.

PROCEEDINGS OF SOCIETIES.

NEWCASTLE CHEMICAL SOCIETY.

General Meeting, October 23, 1879.

Mr. R. C. CLAPHAM, President, in the Chair.

THE minutes of last meeting were read and confirmed.

The Treasurer's statement was presented.

The PRESIDENT—The next business is the reading of the Committee's Report. Members will learn with regret from the Report that Mr. Proctor has been compelled, from failing health, to resign the office of Secretary and Editor of the Transactions. Mr. Proctor has filled the office of Secretary very ably, and I can testify personally that he has brought an amount of knowledge and industry to bear on the reports which was highly commendable. I am sure the Society will agree with me when I say that we have lost in Mr. Proctor a most able and conscientious officer. We can only hope that his successor will endeavour to emulate him.

The Committee's Report was then read as follows :—

Committee's Report.

Your Committee beg to report to the twelfth annual meeting of members that the number now on the Society's books is 141, against 128 last year. The number who joined the first year of the Society's existence was 96, and it is therefore satisfactory to notice a gradual improvement in the numbers. Owing to indisposition and business engagements our much-esteemed colleague, Mr. B. S. Proctor, has been obliged to resign the office of senior Secretary, and the Committee have now to recommend that Mr. J. T. Dunn, of the College of Physical Science, should be elected in his place.

The papers read during the last session were as follows :—"Rozan's Process for Desilverising Lead," by Mr. N. Cookson ; "On the Estimation of Nitrous and Nitric Acids," by Dr. Lunge and Mr. Mactear ; "On Noxious Vapours," by Mr. Hill ; "On a Spring Water containing Manganese," by Mr. H. S. Pattinson ; "On Nitric Nitrogen in Guano," by Mr. Tatlock ; "Chemical Jottings," by Mr. H. R. Procter ; "The Smoke of an Electric Lamp," by Mr. B. S. Proctor.

At the conclusion of the reading of many of the above papers there were useful and interesting discussions, which were the means of adding much information not touched upon in the papers. This was especially the case in an important paper by Mr. Cookson, on the "Separation of Silver from Lead."

In conclusion, the Committee wish again to express a hope that there will be, during the present session, more contributions from the general body of the members, many of whom are so well able to contribute important scientific information.

Mr. SCHOLEFIELD—I move the adoption of the Report, and I should like at the same time to propose a vote of thanks to Mr. Proctor for the able manner in which he has fulfilled the duties of Secretary. With all the remarks which Mr. Clapham has made on this subject I heartily concur.

Mr. H. R. PROCTER—I beg to second the adoption of the Report, and also the vote of thanks to Mr. Proctor.

Both motions were then put to the meeting and carried unanimously.

Mr. William Martyn and Mr. C. E. Stuart were elected members of the Society.

The PRESIDENT—If no member has any remarks to make on the papers which come up for discussion to-night I will proceed to read the paper which I have prepared for this meeting. Although there is no particularly new matter in the paper, I thought it might be useful at this early stage of the production of steel from Cleveland iron to enter the facts, as far as they are known, on our minutes ; at any rate they might be historically interesting. I have found it rather difficult to say anything about a process which is as yet only in its infancy ; but I have consulted a good many ironmasters on the main facts contained in the paper, and have at any rate their authority for its correctness.

"*Extracts relating to the Manufacture of Steel from Cleveland Iron,*" by R. C. CLAPHAM, F.C.S. In an inaugural address, which I delivered last year, and towards the end of that paper, I referred to important experiments that were then being conducted with the object of producing steel from Cleveland pig-iron, in the large way. Since then some practical progress has been made, and steel is now being produced in an experimental plant erected for the purpose by a well-known iron firm at Middlesbro'—at any rate to the extent of a few hundred tons weekly, some quantity of which has already been sold as railway rails. The total quantity of Cleveland pig-iron made annually is about 2,000,000 tons. The importance, therefore, to the North of England of the ultimate success of the steel process cannot be exaggerated, even should it require, as it may possibly do, some years to accomplish.

A very valuable paper was read by Thomas and Gilchrist at the spring meeting of the Iron and Steel Institute held in London, "On the Elimination of Phosphorus in the Bessemer Converter." The difficulty experienced in separating the phosphorus in a puddling furnace, or in a Bessemer converter, is shown in this paper to arise from the hitherto almost universal practice of using fire-bricks or other silicious linings, the silicon when oxidised acting upon the materials as an acid ; whereas an earthy or alkaline base would appear to be necessary both as a lining and as an addition to the melted pig, to give the phosphorus, at the moment of oxidation, a base with which to unite and separate itself from the metal. Mr. Richards has recently adopted a plan of blowing in fine lime through the tuyeres amongst the melted pig, with the object of bringing the base and the metal into more immediate contact. As a cheap material was absolutely requisite, and a material which would stand the great heat in the furnace, lime or magnesian limestone, which is found in such extensive deposits in Durham and Yorkshire, has been fixed upon for this purpose.

From the paper referred to I propose to make a few extracts as follows :—"An examination of the general conditions attending the removal of phosphorus in puddling and refining, taken in connection with the well-known action of silica on phosphate of iron at a high temperature, and the fact that in many other processes in which the temperature is very high, the elimination of phosphorus is not effected, seems to justify the belief, which has doubtless suggested itself to other members, that it is to the silicious (or fire-brick) lining of the ordinary converter and to the consequent necessarily silicious nature of the slag that the one defect of the Bessemer process is due. Under this conviction, at all events, experiments were commenced by the authors about three years ago on the effect of basic lining and basic additions in the several steel-making processes. The lining in these experiments consisted of limestone and silicate of soda, a mixture which had been found to answer well in earlier trials. Some fifty or more blows were made in a vertical converter, and the products analysed, and it was found that when using a basic lining it was generally necessary to continue the blow for over forty seconds after the flame dropped, in order to bring the phosphorus down very low. With this proviso the elimination of phosphorus could be secured with absolute certainty. With a silicious lining on the other hand, the retention of the phosphorus in the metal was as usual, equally invariable even when, as in Mr. Bell's experiments, the blow was continued till a considerable proportion of the iron was oxidised. At the same time more phosphorus and less silica would be found in the slag obtained under these conditions than appears to be the case where large quantities of metal are treated under similar circumstances. It would appear that the presence of a considerable amount of lime is highly favourable, and on a large scale essential, to the removal of phosphorus. Phosphorus was not removed until the slag was sufficiently basic; the effect of large basic additions, in combination with a basic lining, was tried with the object not only of obtaining a highly basic slag at an early stage of the blow, but of rendering the operations independent of the wear of the lining, by which alone the basic character of the slag is otherwise obtained. Advantage was also taken of the fact that lime and oxide of iron are fusible in many proportions. The mixture generally used consisted roughly of one part by weight of 'Blue Billy' and two of lime; this melts in an iron crucible, and may be readily added in a molten condition. It was found, however, that by simply throwing into the converters cheap basic materials, such as lime, even without previous heating, before the pig was introduced, very satisfactory results were obtained without the disadvantage of over-blowing. The following example may be given:—

The pig used contained 1·19 per cent } phosphorus.
1·39 ,,

And the steel produced contained 0·29 per cent } phosphorus.
0·13 ,,
0·04 ,,

The amount of base which it is necessary to add with Cleveland pig generally exceeds 2 cwts. on the ton of iron, and the presence of an excess of base in the slag secures an essential condition of success."

Highly-fired magnesian limestone bricks for the lining are stated to have fulfilled the expectations which were entertained of their probable value. A patent has been taken out by Mr. E. Riley, F.C.S., for the manufacture of pressed limestone bricks. Various liquids were tried with the object of making the lime adhere under pressure while forming the bricks, and at last petroleum oil, coal oil, and resin oil were found to answer the purpose, used in the proportion of 5 to 10 parts of oil to 100 of lime.

The bricks are subject in a kiln whilst baking to a sharp, bright heat, during which operation a considerable shrinking in size takes place, and at the same time the petroleum or other oil slowly burns out, leaving a hard, compact brick, suitable for a lining. A limestone now used as a building stone in London has so far been tried by Mr. Riley in his experiments, which consists of nearly pure magnesian limestone, containing 98·94 per cent carbonates of magnesia and lime.

At the meeting of the same Society, held in Liverpool in September last, similar interest was shown in the practical separation of phosphorus. Three papers were read on the subject.

Mr. A. Pourcel stated that in the dephosphorisation of iron three essential elements must be taken into consideration in the early stage, even of the blast furnaces:—1st. The chemical composition of the cinder; 2nd. The temperature of the place in which the operations are performed; 3rd. The atmosphere in which the reactions take place. The same iron ores, he says, according to the temperature applied in the blast furnace, will produce grey, mottled, white, or cold spongy pig. He found the following results from experiments extended over a period of five years:—

Grey pig contains 0·60 per cent phosphorus on an average.
Mottled ,, 0·38 ,, ,, ,,
White ,, 0·30 ,, ,, ,,
Spongy ,, 0·18 ,, ,, ,,

The highest heat in the blast furnace producing grey pig, and consequently containing the most phosphorus.

Mr R Brown read a paper, in which, instead of getting rid of the phosphorus, he advised that it should be retained in the pig even up to 1·5 per cent, and that its effects should be what he styles "neutralised" by the addition of bichromate of potash in crystals in the proportion of one-half part of chromate to 100 parts of pig in a molten condition. The iron so produced was said by the author to be equal to good steel, and suitable for steel castings or steel plates for shipbuilding. This process, however, would appear on the face of it (even should further trials prove the conclusions to be correct) to be an expensive one, from the difficulty of providing bichromate of potash in sufficiently large quantities and at a cheap rate, owing to the comparative scarcity of the chrome ores.

A third paper, by Mr. H. B. Bull, suggested the separation of the phosphorus by converting it into phosphuretted hydrogen by means of steam blown into the mass of melted iron. However correct this process might be from a chemical point of view, it was shown by Dr. Siemens as likely to be impracticable from the probable rapid cooling of the iron during the time of blowing in the steam.

Possibly in another year we may have still further progress to report in the highly important operation of producing steel from Cleveland iron. In the meantime, large quantities of Bilbao iron ores and other ores suitable for making steel continue to be imported into this district, which appears to be sufficient proof that the new processes are not yet practically completed.

Mr. Berkley—The important part in the process appears to be the material of the bricks used for lining the converters. I had some talk with a gentleman who manufactures these bricks, and was informed that they were made from magnesian limestone, and require to be heated to a very high tenperature in their manufacture. When the bricks are heated alone, they will stand any temperature; but if they come in contact with silica, or with the ordinary silicious bricks, they readily fuse. No doubt bringing magnesia into contact with the iron is the right thing. In this district the marl of the limestone from Fulwell is put into the puddling furnaces, and has a good effect on the iron if not used in excess. If too much is put in, however, it makes the iron red-short. I may say that I do not entertain the gloomy anticipations as to the future of Cleveland if these steel experiments should fail, which are held by some people. For many purposes iron will still be used, and steel will never supersede it. I think that steel rails, however, will always continue to be used; the steel at present exhibits great differences in quality, but doubtless as the manufacture improves these differences will disappear, and we shall be able to obtain steel of uniform quality, even in a large lot.

Mr. Stuart—I should like to ask, firstly, are the bricks so highly heated in their manufacture as to drive off all the CO_2 from the lime and magnesia? Secondly, are they very refractory, as compared, for instance, with glenboig or other silicious bricks? And thirdly, are they hard to handle? The high temperature at which revolvers are now worked renders it difficult to get bricks to stand the heat; we have to pay about 72s. per 1000 for bricks sufficiently refractory for revolver linings, while local bricks could be obtained for about 37s. per 1000. And hardness is a very desirable quality, for unless the bricks are capable of standing a good deal of knocking about, there is a great waste through breakage in the handling. If then these magnesia bricks are free from CO_2, refractory, hard, and obtainable at moderate cost, they would probably be very suitable to line revolver heating furnaces.

Mr. Watson—I happened to be at Eston a few days ago, and saw the manufacture of the bricks. I could not, of course, say from their appearance whether they retained carbonic acid or not, but they are, at any rate, exceedingly hard, for I tried to break one and failed.

Mr. Proctor—Did the bricks exhibit signs of semifusion at all?

Mr. Watson—Yes; they showed marks of fusion on the surface. I was told that they were burnt at a very high temperature, and lost about 50 per cent of their bulk in the process.

Mr. Proctor—Do they stand moisture? For if they are simply lime and magnesia they might be expected to slack on exposure to air and damp.

Mr. Stuart—Mr. Proctor's question is very important; possibly the semi-fused coating may have the effect of protecting them to some extent.

Mr. Clapham—Lime formed into a very hard and compact mass is difficultly acted on even by acids.

Mr. Swan—I should like to say that the idea of magnesia bricks is not new. Similar bricks were made in Paris some years ago by Tessié du Motay and Maxwell Lyte, of pure magnesia.

Dr. Affleck—Magnesia does not slack, and that is the chief reason why a magnesian limestone is sought for. I do not see why lime should not slack, however hard it may be.

Mr. Berkley—In making hematite pig, where the slag contains a very large amount of lime, we find that the slag does not stand the atmosphere at all but crumbles away, while our Cleveland slag is unaffected by it.

Mr. Proctor—How does lime which has been exposed to the oxyhydrogen flame behave?

Mr. Swan—The point on which the flame impinges is so small that it would be difficult to separate from the rest of the lime, and I don't know that any observations have been made on it.

Mr. Stuart—Hard-burnt lime is very difficult to slack, and very likely the same may be the case with these bricks. I should like to know the cost of the bricks.

Mr. Berkley—I believe 60s. per 1000.

Mr. Watson—I noticed that the magnesia bricks at Eston were kept under cover, while the silicious bricks were exposed to air.

Mr. France then proposed, and Mr. Watson seconded a motion, that a vote of thanks be given to the President for his interesting paper.

The motion was carried unanimously.

The meeting then terminated.

CORRESPONDENCE.

DETERMINATION OF SULPHUR IN COAL.

To the Editor of the Chemical News.

Sir,—The process for determination of sulphur in coal and coke by combustion with calcium hydrate, which was referred to by Dr. Divers in a note to a paper read at the Chemical Society's meeting, as reported in your last issue, did not owe its origin to Mr. Pattinson, but to myself, and was published by me in the Chemical News in 1874. I may also state that the method given in the paper just read before the Chemical Soctety was communicated to me by Mr. James Hargreaves, of Widnes, as far back as 1869.—I am, &c.,

W. F. K. Stock.

5, Dixon Terrace, Darlington,
November 17, 1879.

MISCELLANEOUS.

Improvements in Gas-Furnaces.—We have frequently had occasion to call attention to the improvements effected in blowpipe apparatus and gas-furnaces by Mr. Fletcher, of Warrington. His improved blast-furnaces, crucible and muffle furnaces, automatic blower and aspirator, and chemical blowpipe are all great improvements on the old forms of apparatus. He has recently made a "Solid Flame Burner" and a "New Evaporating Burner," both of which we have used in our laboratory, and the results fully justify the advantages referred to by the inventor in his catalogue. The solid flame burner is five inches high, and requires much less gas than the old form of heating burner to do the same amount of work. It is, moreover, free from smell. The flame appears to be the same temperature throughout. The inventor says that it will boil half a gallon of water in a flat copper kettle in five minutes, and will melt 6lbs. of lead or solder in an iron ladle in seven minutes. The evaporating burner for glass and porcelain vessels and general laboratory work is a great improvement on the ordinary coil burners in use, owing to the fact that no currents of cold air, which are so fatal to glass and porcelain dishes, can reach the vessel, as is the case with all coil burners. The flames are blue and smokeless, and are not liable to be extinguished with a splash, being raised above the body of the burner.

The Royal Society Medals.—The Council of the Royal Society have awarded the Copley Medal to Prof. Rudolph J. E. Clausius, of Bonn, for his well-known researches upon heat; the Davy Medal to M. Lecoq de Boisbaudran, for his discovery of gallium; a Royal Medal to Mr. William Henry Perkin, F.R.S., for his synthetical and other researches in organic chemistry; and a Royal Medal to Prof. Andrew Crombie Ramsay, F.R.S., for his long-continued and successful labours in geology and physical geography.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin
No. 12, 1879.

Methyl-pyrogallic Acid and the Formation of Pittacall.—A. W. Hofmann.—The author has already shown that cedriret and pittacall are both derived from the secondary methyl-ether of pyrogallic acid. He now regards pittacall as a base corresponding to rosanilin, a hexa-methoxylised rosolic acid. The author further describes the salts of eupittonic acid, the oxidation of a mixture of pyrogallic acid diethyl-ether with methyl-pyrogallic acid dimethyl-ether. The acid formed from a mixture of these two ethers in presence of ammonia readily passes into the corresponding tinctorial base.

Decomposition of Sulph-hydantoin by Barium Hydrate.—R. Andreasch.—The formation of thioglycolic acid from sulph-hydantoin by the action of an alkaline solution explains in the simplest manner why all attempts to desulphurise sulph-hydantoin in order thus to arrive at a glycolyl-amid lead merely to negative results.

Reaction with Iron Peculiar to Thioglycolic Acid.—R. Andreasch.—If the slightly acidulated solution of a thioglycolylate, or also a solution of the free acid, is mixed with a drop of a very dilute solution of ferric chloride, a very transient indigo blue colouration appears in the liquid, but if the liquid is then made alkaline with a few drops of ammonia a dark red colouring, bordering on violet, appears, and becomes more intense on shaking with air. If too much ferric chloride is added, on supersaturation with ammonia hydrated ferric oxide falls without any change of colour.

Behaviour of Hæmatoxylin on Dry Distillation.—R. Meyer.—From the distillate a crystalline phenol mixture is easily separated, in which pyrogallic acid (as gallein and resorcin; as fluorescein) are readily detected. Hæmatoxylin is a mixture of the above mentioned phenols.

Nitronaphthoeic Acids.—A. G. Ekstrand.—Not adapted for useful abstraction.

Determinations of Specific Gravities.—F. W. Clarke.—Not suitable for abstraction.

Amido Derivatives of Diphenyl-amin.—R. Nietzki and O. N. Witt.—An account of mono- and di-amido-diphenyl-amin.

MEETINGS FOR THE WEEK.

Saturday, 22nd.—Physical, 3. "On a Retention Image Photometer," Dr. F. Guthrie. "A Hint as to the Constitution of Chlorine," Prof. A. W. Rücker, "The Influence of Heat upon Certain Forms of Induction Coils," R. C. Shettle, M.D. "The Crossley Telephone Transmitter," Walter Emmott.
Monday, 24th.—Geographical, 8.30.
—— Medical, 8.
—— Society of Arts, 8. (Cantor Lecture). "Chemistry of Bread and Bread Making," Dr. Graham.
Tuesday, 25th.—Civil Engineers, 8.
—— Anthropological Institute, 8.
Wednesday, 26th.—Society of Arts, 8.
Thursday, 27th.—Royal, 8.30.
—— Philosophical Club, 6.30.
Friday, 28th.—Quekett Club, 8.

CHRISTMAS LECTURES.

ROYAL INSTITUTION OF GREAT BRITAIN.

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TO INVENTORS AND PATENTEES.

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ROYAL POLYTECHNIC. —— GHOST ILLUSIONS; The Puzzled Artist, The Knight Watching his Armour, daily by Mr. J. L. King.—THE PHYSIOSCOPE, MICROSCOPE, KALEIDOSCOPE, CHROMATROPES, &c. —EDISON'S LOUD SPEAKING TELEPHONE, demonstrated by Mr. T. C. Hepworth.—The latest and most wonderful invention in DIVING, Fleuss's Apparatus, enabling the Diver to remain under water any length of time, without any assistance from or connection with the surface, demonstrated in the Large Tank by the Inventor,—THE CHEMISTRY OF COAL, an Experimental Lecture, and FLASHING SIGNALS, by Mr. J. L. King.—CAVES AND CREVICES, by Mr. T. C. Hepworth.—INSTRUMENTAL CONCERT by the talented Mdlles. and Master Paggi.—GRAND POPULAR VOCAL CONCERT under the direction of Mr. Stedman, every Monday at 9. Admission to the Institution 1s. Open 10 till 1, 2 till 5, and 6 till 10.

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AND

JOURNAL OF PHYSICAL SCIENCE.

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THE CHEMICAL NEWS.

Vol. XL. No. 1044.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 244.)

I. Principles of the Periodic Law.

Analogies have long been noticed between the elements of high atomic weights and those of low ones. Claus observed that Os, Sr, and Pt, whose atomic weights are about 195, have analogous properties with Ru, Rh, and Pd, which have much lower atomic weights, viz., about 105.

Marignac noticed the analogy of Ta=182 and W=184, with Nb=94 and Mo=96.

To Au and Hg correspond the lighter analogues Ag and Cd, as well as the still lighter ones Cu and Zn.

Cæsium and barium are analogues of potassium and calcium, and so on.

Comparisons of this nature lead to the idea of classifying all the elements according to their atomic weights, and in making this list we find reciprocal relations of a remarkable simplicity. As an example we will give all the elements whose atomic weights are between 7 and 36. *These atomic weights are here arranged in arithmetical order according to their value.*

Li = 7; Be = 9.4; B = 11 ; C = 12; N = 14; O = 16; Fl = 19
Na = 23; Mg = 24 ; Al = 27·3; Si = 28; P = 31; S = 32; Cl = 35·5.

It is plainly shown that the character of the elements is subjected to regular modifications, and little by little, step by step, as the atomic weights vary, it is also periodically modified; that is to say, in the same manner in the two series, so that the corresponding members of these series are analogous. Na and Li, Mg and Be, C and Si, O and S, and so on. The corresponding elements in the two series have the same kind of compounds, and they have, as it is generally said, the same atomicity. The most important circumstance is that the forms of compounds of intermediate elements obey the laws which have been discovered in comparing the hydrated and oxygenised compounds of the elements which precede and follow after. This regularity proves that the elements just mentioned form two natural series in the order in which they are placed, and can neither of them have any intermediate members. Thus the last four members alone can combine with hydrogen, forming, if R represents an element:—

$$— \quad — \quad — \quad RH_4 \quad RH_3 \quad RH_2 \quad RH.$$

The constancy or destructibility of these hydrogen compounds under various influences, as well as their acid character or the faculty of changing hydrogen for metals, and other properties, are gradually modified, according to the position of the elements in the series. HCl is a very decided acid of great stability; H_2S is a weak acid, decomposed by heat; in H_3P the acid character has completely disappeared, and the instability has increased; again, it is much more decided in H_4Si.

All the elements of the second series enter into combination with oxygen. It is therefore in these compounds that we can best observe how the properties of elements are gradually modified, according as the atomic weight changes. As examples for comparison of this kind we will take the higher anhydrous oxides, by which I mean those which correspond to water, which can combine with it and form hydrates, and unite amongst themselves to form salts. We will not here take notice of those oxides which by their composition and properties correspond to peroxide of hydrogen (such as Na_2O_2), because there are only a small number of elements capable of forming such compounds.

The seven elements of the second series give the following higher oxides capable of forming salts:—

$$Na_2O;\ Mg_2O_2;\ Al_2O_3;\ Si_2O_4;\ P_2O_5;\ S_2O_6;\ Cl_2O_7;$$
$$\text{or } MgO; \quad \text{or } SiO_2; \quad \text{or } SO_3$$

Thus, in a determinate order, seven forms of oxidation known to chemists correspond to the seven members of the above series. Although they have long been discovered, their connection with the fundamental properties of elements remains unknown. We see, by examining these seven forms, that to their position corresponds a diminution of the basic properties and an increase of the acid properties. They give the following normal saline derivatives:—

$$NaX,\ MgX_2,\ AlX_3,\ SiX_4,\ PX_5,\ SX_6,\ ClX_7.$$

For example—

$$Na(NO_3);\ MgCl_2;\ Al(NO_2)_3;\ Si(KO)_4;\ PO(NaO)_5;$$
$$SO_2(NaO)_2;\ ClO_3(KO).$$

We can represent X by the following elements:—

$$X = H,\ Cl,\ NO_3,\ OH,\ CH_3,\ K,\ OK,\ \&c.$$

And, further—

$$X_2 = O,\ S,\ SO_4,\ CO_3,\ \&c.$$

To PX_5 correspond:—

$$PCl_3,\ POCl_3,\ P_2O_5,\ PO(OH)_3,\ POH(OH)_2,\ POH_2(OH),$$
$$PH_4I,\ PH_3HI.$$

In the composition of hydrates we again notice a complete regularity—

$$Na(OH);\ Mg(OH)_2;\ Al(OH)_3;\ Si(OH)_4;\ PO(OH)_3;$$
$$SO_2(OH)_2;\ ClO_3(OH).$$

In the hydrates there are only four hydroxyls, $(OH)_4$; and in the same manner in the oxides there are only four oxygen atoms, O_4. The highest forms of combination known with an element R are RO_4, RH_4, and $R(OH)_4$. No stable hydrate, $S(OH)_6$, corresponds with the type SX_6, although corresponding basic salts are known. This hydrate is transformed by elimination from $2H_2O$ into $SO_2(HO)_2$, which contains O_4, resembling in this manner,

$$Si(OH)_4,\ PO(OH)_3,\ ClO_3(OH).$$

It is not only in the forms of compounds of elements placed according to the amount of the atomic weights that we notice a regular connection, but also in their other chemical and physical properties.

At the beginning of the series are the bodies of a decided metallic character; at the end are the representatives of the metalloids. The former possess basic properties, the latter acid ones; while the bodies in the middle have intermediate properties. In Li_2O and Na_2O the basic properties are more clearly defined than in BeO and MgO; in B_2O_5 and Al_2O_3 they are only feebly shown, and these compounds have some acid properties. CO_2 and SiO_2 have only acid properties, although in only a small degree. This character is more pronounced in N_2O_5 and P_2O_5; and again in SO_3 and Cl_2O_7.

To show with what regularity the physical properties are modified in the above-mentioned series we give the modifications of the specific weights and the atomic volumes of the members of the second series:—

	Na.	Mg.	Al.	Si.	P.	S.	Cl.
Density	0·97	1·75	2·67	2·49	1·84	2·06	1·33
Atomic volume	24	14	10	11	16	16	27
	Na_2O.	Mg_2O_2.	Al_2O_3.	Si_2O_4.	P_2O_5.	S_2O_6.	Cl_2O_7.
Density	2·8	3·7	4·0	2·6	2·7	1·9	?
Atomic volume	22	22	25	45	55	82	?

The volatility diminishes in the members of the commencement of the first series from Na to Si; from thence it increases. The same observation applies to the oxides, amongst which the middle ones, MgO, Al_2O_3, SiO_2, are the most refractory.

The compounds of metals at the beginning of the series with other metals are called alloys; they have the look and the properties of metals. Even in the case of phosphorus and sulphur these properties are not completely effaced, for phosphide of copper, sulphide of lead, and other compounds still retain something of a metallic look. On the contrary, oxides and metallic chlorides (such as many compounds of phosphorus and sulphur) resemble salts.

All the other elements can be arranged in analogous series, more or less complete; for example, the silver series.

Atomic weights.

Ag = 108 ; Cd = 112 ; In = 113 ; Sn = 118 ; Sb = 122 ;
Te = 125 (?) ; I = 127.

I shall only give the density of these bodies, because their concordance with the preceding series with regard to the other properties needs no explanation.

Density.

Ag = 10·5 ; Cd = 8·6 ; In = 7·4 ; Sn = 7·2 ; Sb = 6·7 ;
Te = 6·2 ; I = 4·9.

(To be continued.)

ON THE

SOLUBILITY OF SOLIDS IN GASES.[*]

By J. B. HANNAY, F.R.S.E., F.C.S., and JAMES HOGARTH.

(Preliminary Notice.)

This investigation was undertaken in the hope that, by an examination of the conditions of liquid matter up to the "critical" point, sufficient knowledge might be gained to enable us to determine under what particular conditions liquids are dynamically comparable, in order that the microrheometrical method[†] (which the Royal Society has done one of us the honour of publishing in the *Philosophical Transactions*) might be applied to determine their molecular mass and energy relations. It seemed that as the laws relating to gases and liquids merge at what was called by Baron Cagnaird de la Tour[‡] "l'état particulier," and by Dr. Andrews[||] the "critical point," an examination of matter up to the limit of the liquid state would be likely to yield us much information. The time we have to devote to scientific work being very limited, we found that it was quite impossible to make much advance by using the apparatus devised by Dr. Andrews, as the time required to change from one liquid to another was more than we had at our disposal. We therefore devised a new apparatus, which will be described in a more lengthy communication, but which, we may state, can be opened, the liquid changed, and again closed for a new experiment, in about one minute.

The question as to the state of matter immediately beyond the critical point being considered by Dr. Andrews to be at that time incapable of receiving an answer, we imagined that some insight might be gained into its condition by dissolving in the liquid some solid substance whose fusing point was much above the critical point of the liquid, and noticing whether, on the latter passing its critical point and assuming the gaseous condition, the solid was precipitated or remained in solution. We found that the solid was not deposited but remained in solution, or rather in diffusion, in the atmosphere of vapour, even when the temperature was raised 130° above the critical point, and the gas was considerably expanded. When the side of a tube containing a strong gaseous solution of a solid is approached by a red-hot iron, the part next the source of heat becomes coated with a crystalline deposit, which slowly re-dissolves on allowing the local disturbance of temperature to disappear. Rarefaction seems to be the cause of this deposition, because if the temperature be raised equally and the volume retained at its original value, no deposition takes place. Those experiments have been done with such solvents as alcohol (ethyl and methyl), ether, carbon disulphide and tetrachloride, paraffins, and olefines, and such solids as sulphur, chlorides, bromides, and iodides of the metals, and organic substances such as chlorophyll and the aniline dyes. Some solutions show curious reactions at the critical point. Thus ethyl alcohol, or ether, deposits ferric chloride from solution just below the critical point, but re-dissolves it in the gas, when it has been raised 8° or 10° above that temperature.

It appeared to us to be of some importance to examine the spectroscopic appearances of solutions of solids when their liquid menstrua were passing to the gaseous state; but as all the substances we have yet been able to obtain in the two states give banded spectra with nebulous edges, we are only able to state that the substance does not show any appreciable change at the critical point of its solvent. Such was the case with anhydrous chloride of cobalt in absolute alcohol. It was suggested to us by Prof. Stokes that the substance obtained by the decomposition of the green colouring matter of leaves by acids, and which yields a very fine absorption-spectrum, might be useful for our purpose. We have prepared the substance according to the careful directions kindly furnished us by Prof. Stokes, and find that it shows the phenomenon in a marked manner, whether dissolved in alcohol or ether. The compound is easily decomposed by heat under ordinary circumstances, and yet can be dissolved in gaseous menstrua, and raised to a temperature of 350° without suffering any decomposition, showing the same absorption-spectrum at that elevated temperature as at 15°.

We considered that it would be most interesting to examine by this method a body such as sodium, which, besides being an element, yields in the gaseous state sharp absorption-lines. An opportunity seemed to be afforded by the blue solution of sodium in liquefied ammonia, described by Gore,[*] but we found that, on raising the ammonia above its critical point, the sodium combined with some constituent of the gas, forming a white solid, and yielding a permanent gas, probably hydrogen.

There seems, in some cases, to be a slight shifting of the absorption-bands towards the red, as the temperature rises, but we have as yet been able to make no accurate measurements.

When the solid is precipitated by suddenly reducing the pressure it is crystalline, and may be brought down as a "snow" in the gas, or on the glass as a "frost," but it is always easily re-dissolved by the gas on increasing the pressure. These phenomena are seen to the best advantage by a solution of potassic iodide in absolute alcohol.

We have, then, the phenomenon of a solid with no measurable gaseous pressure dissolving in a gas, and not being affected by the passage of its menstruum through the critical point to the liquid state, showing it to be a true case of gaseous solution of a solid.

Determination of the Elements of a Vibratory Movement: Measurement of Amplitudes.—M. Mercadier.—The author uses a so-called vibratory micrometer, a scale divided into millimetres, or fractions of a millimetre, intersected by a transverse line, extending to the zero of the scale, and forming with it a small angle. This may be either engraved upon the vibrating body itself, or upon a plate of glass, &c., fixed to the body so that this angular micrometer may share its vibrations, the scale being perpendicular to their direction.—*Comptes Rendus.*

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[*] A Paper read before the Royal Society, November 20, 1879.
[†] 'On the Microrheometer, *Phil. Trans. Roy. Soc.*, 1879.
[‡] *Ann. Chim.*, Series 2me, xxi., p. 127; xvii., p. 410.
[||] "Bakerian Lecture," *Phil. Trans. Roy. Soc.*, 1869, p. 588.

[*] *Proc. Roy. Soc.*, vol. xxi., p. 145.

NON-PRODUCTION OF OZONE IN THE CRYSTALLISATION OF IODIC ACID.

By ALBERT R. LEEDS, Ph.D.

It has been stated by Prof. H. H. Croft[*] that air over crystallising iodic acid becomes ozonised. In preparing the acid according to Millon's process, Prof. Croft noticed that when the acid was left to crystallise over oil of vitriol the air in the jar (over the drying dish) had the characteristic odour and gave the usual tests of ozone. He states that the solution in every instance was boiled down to thin syrup, so that no trace of chlorine or nitric acid could possibly have remained. The air in the jar was tested from day to day, both by the smell and the action upon iodo-starch paper. Even when a few crystals began to form no change was noticed; but when the crystallisation set in fully the evolution was most remarkable, the strong smell being quite characteristic, and entirely different from that of chlorine or nitric acid.

We have repeated these experiments, and have found that the phenomena may be quite differently interpreted. After preparing the potassium iodate, by oxidation of iodine by means of potassium chlorate and nitric acid, and expulsion as far as possible of free chlorine from the solution, the potassium was converted into the barium salt, and the latter washed thoroughly. This was then decomposed by an equivalent weight of sulphuric acid, and, after separation from the insoluble salt, the solution of iodic acid was evaporated nearly to the point of crystallisation. It was then transferred to a retort, which was connected with three Geissler washing-apparatus, the first empty, the second and third containing water, and the last attached to a tube in which were placed ozonoscopes. Iodo-starch papers were likewise inserted in tubes placed in the neck of the retort. On aspirating a stream of desiccated air through the apparatus, the test-papers in the space above the iodic acid turned blue even before crystallisation set in. At the end of six hours they began to bleach, and at the expiration of twenty-four hours had become colourless. The test-papers exposed to the current *after* its washing through the small amount of water contained in the Geissler bulbs remained colourless throughout this and all succeeding trials. The strong odour given off from the crystallising solution was compared from time to time with the ozone generated by an electrical ozoniser, and was found to be essentially different in character. The crystallised iodic acid was then re-dissolved in the smallest possible amount of water, and re-crystallised in the same manner. The ozonoscopes in the space above the crystallising iodic acid were not affected on this repetition of the crystallisation. Now, when the difficulty of getting rid of every trace of extraneous matter by chemical operations—however carefully conducted—is borne in mind, the simplest explanation of the above phenomena, it appears to me, is that the apparent ozonic reaction is not due to ozone produced in the act of crystallising,—which, as Prof. Croft remarks, is anomalous—but to a trace of chlorine or nitrous acid, or possibly some lower oxide of iodine formed in the process of manufacture, and eliminated by successive crystallisations of the acid. The fact that the air after washing did not manifest the ozone reaction strongly corroborates this view.

NEW AND OLD VIEWS ON THE NASCENT STATE OF BODIES.

By Dr. T. L. PHIPSON.

In my note on this subject, in the Chemical News (vol. xl., p. 184), I called attention to some statements by Prof. Tommasi published in this journal (vol. xl., p. 171). The author has since replied in an interesting paper (vol. xl., p. 245), and it is evident that our opinions on the nascent state of bodies are not quite so divergent as his first note led me to expect.

Many chemists will doubtless have been misled by the title of Dr. Tommasi's first note, "On the Non-Existence of Nascent Hydrogen"; but it appears by his second note that he admits its existence, for he says:—"The reductive power of nascent hydrogen varies according to the chemical reaction which produces it. And if this gas in the nascent state possesses greater affinity than in the natural state, it is solely due to the fact that the hydrogen, the moment it issues from a combination, is found to be accompanied by the whole quantity of heat produced during the setting free of the hydrogen." So that the author not only does *not* deny the existence of nascent hydrogen, but actually supports it by a theory of his own. This is all I contended for.

Dr. Tommasi hopes that I may accept his thermic theory. It is, perhaps, as good as another; but if the word *heat*, in the paragraph just quoted, be replaced by *electricity*, this thermic theory becomes identical with that published in 1858 in my "Force Catalytique, &c." (quoted in my previous note). Whether the thermic theory will explain such facts as those given on pages 29, 30, and 31 of my paper better than the electric theory still remains to be proved; whilst the paragraph on page 34 of that work will convince him that I was occupied with this subject as early as 1857; that is, not only before Tommasi, but before Houzeau.

But by whatever theory these curious reactions may be explained, there can be no doubt that Dr. Tommasi has made known several new and very interesting facts concerning reductions operated by hydrogen; and he will be the last person not to see the identity of the reduction of auric chloride by hydrogen gas *in presence of platinum*, for instance, with the phenomena of hydrogen in the nascent state.

His argument that *heat* will produce the same result, when the temperature of the hydrogen gas is raised, is rather old,—it will also be found in my "Force Catalytique" already quoted—but we may use the same argument and substitute the word "electricity."

After all what is *caloric?* It is not a material substance that can be introduced into a body like raisins into a cake. The electric action can be put in evidence by the galvanometer more directly than the thermic condition can be rendered manifest by the calorimeter; and, as caloric and electricity are mutually convertible agencies, replacing each other equivalent for equivalent, as Grove and others have long since shown, it is no doubt difficult to admit that either one or the other is, in all cases, essentially the cause of the "nascent state" of bodies.

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ON CLARKE'S METHOD FOR THE SEPARATION OF TIN FROM ARSENIC AND ANTIMONY.

By FRED. P. DEWEY.

In the beginning of the year 1876 an investigation was undertaken on the separation of tin, arsenic, and antimony. After some study on the published methods, and some work on a few of them, it was decided to make a thorough investigation of the method proposed by F. W. Clarke,[*] as that seemed the most favourable method, notwithstanding the poor results obtained by G. C. Wittstein.[†] Clarke's method is to add to the solution of the metals prepared as for the precipitation of sulphides, oxalic acid in the proportion of twenty parts to one of tin, keeping the solution so concentrated that oxalic acid will separate in the cold.

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[*] Chemical News, vol. xxv., p. 87; *American Journal of Science*, III., p. 466; *Canadian Journal*, xiii., No. 3.

[*] *Am. Jour. Sci.*, 49, 145.

[†] *Fresenius's Zeitschrift*, 9, 487.

Hydrogen sulphide gas is then passed through the boiling solution until the antimony and arsenic are all precipitated. The solution is allowed to stand in a warm place for half an hour, the sulphides are filtered off, and separated according to any of the well-known methods. The filtrate is neutralised by ammonia, the precipitate formed dissolved in ammonium sulphide, and acetic acid added in excess, whereby the tin is precipitated as a light coloured mixture of sulphide and oxide, which soon darkens in colour. When complete precipitation is ensured by standing in a warm place several hours, it is filtered off, washed in ammonium nitrate solution, ignited, and weighed as stannic oxide, SnO_2. The results given by Clarke were the recovery of 99·93 and 99·57 per cent of the tin from solutions containing unknown amounts of antimony and arsenic, the latter result being considered poor by him, and owing to incomplete precipitation from filtering too soon after the addition of reagents. It was originally intended to investigate the separation of tin from antimony and tin from arsenic separately, and then tin from antimony and arsenic; but it soon became evident that, with the time at my disposal, I could only undertake the separation of tin from antimony, and the experiments here described were devoted entirely to that object.

I made two separations, intending to follow Clarke's plan exactly. Pure metallic antimony was weighed out and dissolved in strong hydrochloric acid with the addition of potassium chlorate. As soon as all the antimony had gone into solution, weighed amounts of pure metallic tin were added, and the final solution evaporated to dryness to drive off hydrochloric acid and decompose all potassium chlorate: the residue was taken up in a few drops of hydrochloric acid and water, and the requisite amount of oxalic acid added. As oxalic acid is soluble in 10 parts of cold water,* one solution could not be over 55 c.c. and the other over 39 c.c., no account being taken of the few drops of hydrochloric acid added. Hydrogen sulphide was transmitted through the boiling solution for half an hour, when the antimony seemed to be all down. After standing for half an hour in a warm place, a portion of the fluid was run through a weighed filter, and the filtrate tested with hydrogen sulphide, when more antimony came down; this was filtered off, and the second filtrate tested, when still more antimony came down. Thereupon I gave up the idea of keeping the solution so concentrated, and diluted it a little, when the antimony came down, so that on testing the filtrate by diluting and adding more hydrogen sulphide no antimony was precipitated. The precipitate was filtered off, washed well, dried at 100° C., and weighed. The filtrate was diluted largely, ammonia added, the slight precipitate dissolved in ammonium sulphide, acetic acid added in excess, and the whole allowed to stand over-night, when the precipitate was filtered off, washed in ammonium nitrate, ignited, and weighed as stannic oxide, SnO_2:—

Used.		Found.	
Sb.	Sn.	Sb.	Sn.
0·3089 gr.	0·2722 gr.	0·3063 gr.	0·2704 gr.
0·2671 ,,	0·1908 ,,	0·2704 ,,	0·1821 ,,

In a second set a portion of the antimony trisulphide was heated to 230° C. in a tube filled with dry carbon dioxide, and the loss calculated for the whole precipitate:—

Used.		Found.	
Sb.	Sn.	Sb.	Sn.
0·1542 gr.	0·2705 gr.	0·1356 gr.	0·2717 gr.
0·1172 ,,	0·3736 ,,	0·1186 ,,	0·3760 ,,

Some qualitative experiments were undertaken to test the influence of free hydrochloric acid on the separation, and also the statement of Clarke that antimony could not be detected in the filtrate from the antimony trisulphide either by the Marsh test or the black stain on platinum with zinc, and that oxalic acid did not interfere with either of these tests. I found that oxalic acid obscured the platinum and zinc test by the formation of a dense white coating on both the platinum and zinc when the acid became nearly neutralised (probably an oxalate of zinc), which completely masked any black stain that might have been produced on the platinum, but that it did not obscure the Marsh test in the least. Five solutions were prepared as before, each solution containing 0·2 gr. tin and 0·15 gr. antimony, and evaporated to dryness, the residues being taken up in oxalic acid; and, starting with no free hydrochloric acid, 1, 3, 5, and 7 c.c. of hydrochloric acid of 1·09 sp. gr. were respectively added. These solutions were diluted to 250 c.c. Hydrogen sulphide was transmitted through the boiling solutions for three-quarters of an hour, and the antimony trisulphide filtered off. The filtrates were tested in an ordinary Marsh apparatus.

No. 1 containing no HCl gave only a slight yellowish mirror, probably S.

No. 2 containing 1 c.c. HCl gave a metallic mirror for about two minutes.

No. 3 containing 3 c.c. HCl gave a good metallic mirror for some time.

No. 4 containing 5 c.c. HCl gave a very good metallic mirror for a long time, about equal portions of the filtrates being used for each test.

No. 5 containing 7 c.c. HCl deposited thin red flakes of Sb_2S_3 on concentration.

These results show that to get the best separation no hydrochloric acid can be present, although a very small amount can be present without exerting any very great solvent action on the antimony trisulphide.* The precipitates of antimony trisulphide were dissolved in strong hydrochloric acid, evaporated, and treated with zinc: the metallic precipitates were treated with small amounts of dilute hydrochloric acid, filtered, and the filtrates tested with mercuric chloride, when heavy precipitates of mercurous chlorides came down in every case. These results show that it is always necessary to make double precipitations of the antimony, a point suggested by Clarke as being necessary only when great accuracy is required. The results of the above described experiments indicate that the following modifications of the original plan are required, viz., a solution *without free mineral acids*, and diluted to 250 c.c. for 0·2 gr. of each metal; also, in all cases a double precipitation of the antimony.

Solution in hydrochloric acid with potassium chlorate being rather tedious, a mixture recommended by Dr. Clemens Winckler, *Fresenius's Zeitschrift*, consisting of 1 part strong nitric acid, 4 parts strong hydrochloric acid, and 5 parts water, was tried and found very satisfactory. The evaporation of a solution of tin and antimony prepared by this mixture cannot safely be undertaken, on account of the well-known fact that stannic chloride will volatilise from a dilute acid solution, and both stannic chloride and antimony trichloride from a concentrated acid solution on evaporation, and the use of an alkali to neutralise the acid, is objectionable for reasons I shall state beyond; but from the fact that in the analyses given the metals were dissolved in hydrochloric acid and potassium chlorate and evaporated to dryness without any very great loss on the total amount of metals used, it suggested itself that the presence of a sufficient amount of potassium chloride to form double salts with all of the tin and antimony used would serve to fix the tin and antimony during evaporation. Two experiments were made to ascertain definitely whether tin or antimony would volatilise under such conditions. 1·7 grs. of tin were dissolved in 50 c.c. of the aqua regia and 2·5 grs. of potassium chloride were added. The solution was transferred to a retort of 350 c.c. capacity, diluted to 100 c.c., and distilled at about 100° C. in an air-bath, while a slow current of air was forced through the retort. When half of the fluid had passed

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* Storer's "Dictionary of Solubilities."

* The poor results obtained by Wittstein were probably due to the presence of large amounts of free acid in his solutions.

over, the receiver was removed, emptied, and returned, then the distillation was resumed. The distillate was diluted to 100 c.c., part of the acid was neutralised by sodium carbonate, and hydrogen sulphide was transmitted through it, when there was only a slight separation of sulphur, probably caused by chlorine given off from the aqua regia. The distillation was carried to dryness, the distillate treated in the same way, and with the same result. A second portion of tin was treated in the same way, omitting the addition of potassium chloride, and in each portion of the distillate heavy precipitates of tin sulphide were obtained. 1·5 grs. of antimony were treated exactly as the tin in the first experiment with the same result. 1·5 grs. more of antimony were treated without potassium chloride. In the first distillate, containing three-quarters of the liquid, no antimony could be detected, but in the final distillate a large amount of antimony was found. These experiments show that solutions of stannic chloride and antimony trichloride containing free hydrochloric or nitric acid, or both, can be safely evaporated to dryness if a sufficient amount of potassium chloride is present. In all of my subsequent analyses the free acid was removed by evaporation to dryness in the presence of an excess of potassium chloride.

The course next adopted was to dissolve about 0·2 gr. of each metal in the aqua regia, add sufficient potassium chloride, and evaporate to dryness. The requisite amount of oxalic acid was then placed in the beaker, and boiling water added until a clear solution was obtained, which is very easy to do. The solution was diluted to 250 c.c. Hydrogen sulphide was transmitted through the boiling solution for half an hour. The precipitate was immediately filtered off[*] and washed. The precipitate of antimony trisulphide containing a little tin sulphide was dissolved in ammonium sulphide. This solution was poured into a boiling solution of oxalic acid, containing enough of the acid to decompose the ammonium sulphide, and still have sufficient excess to hold the tin in solution. Hydrogen sulphide was transmitted through the boiling solution for ten minutes, and the solution filtered through a weighed filter. The precipitate was well washed with hot water, dried at 100° C., weighed, and a portion converted into pure anhydrous antimony trisulphide as before. The filtrates containing the tin were united and treated with the proper reagents. The precipitate was filtered off after standing, washed in ammonium nitrate, and weighed as tin oxide. Each filtrate was always tested to ensure complete precipitation :—

Used.		Found.	
Sb.	Sn.	Sb.	Sn.
0·2243 gr.	0·2238 gr.	0·2390 gr.	0·2218 gr.
0·1908 ,,	0·2346 ,,	0·2058 ,,	0·2219 ,,
0·3871 ,,	0·2573 ,,	0·3949 ,,	0·2607 ,,
0·3108 ,,	0·2187 ,,	0·3158 ,,	0·2203 ,,

Repeated testings of the weighed tin and antimony indicated that the actual separations were satisfactory. There were, however, some difficulties and some obvious sources of error in the methods used for their determinations which would cause gain of antimony and gain or loss of tin. On dissolving the antimony sulphide in strong hydrochloric acid a black residue was always obtained, no matter how much the precipitate had been washed, indicating the presence of oxalic acid in the precipitate in some form. The solution of tin required extreme dilution to get it all down, the solution being diluted in one case to nearly 1500 c.c., which seemed to be due to the unavoidable presence of large amounts of ammonium oxalate. Besides this, the washing of the tin precipitate was very difficult and tedious indeed, which is a reason for keeping the amount of salt in the solution as small as possible.

To avoid the difficulty of precipitating the tin completely and washing it thoroughly, it seemed necessary to remove the oxalic acid entirely from the filtrates containing it. Strong sulphuric acid was decided upon as the best means—that is, to evaporate the solution to dryness, and treat with strong sulphuric acid at about 100° C., which rapidly decomposes the oxalic acid into water, carbon monoxide and dioxide. In two experiments 0·5 gr. tin was dissolved in the aqua regia, potassium chloride was added, the solutions were evaporated to dryness, and the residues taken up in oxalic acid, 25 grs. in the one and 30 grs. in the other. They were again evaporated to dryness, and treated with about 40 c.c. of strong sulphuric acid at 100° C. until all effervescence had ceased, when they were diluted to 500 c.c., treated with hydrogen sulphide gas for half an hour and allowed to settle, after which the precipitates were filtered off, washed in ammonium nitrate, and weighed as tin oxide, yielding 0·4998 and 0·4996 gr. tin. Applying this process to the filtrate from the antimony trisulphide, the following separations were next made, the process being conducted as before except the dilution of the solution before the precipitation of the antimony trisulphide to 400 c.c., when 0·5 gr. of each metal were used :—

Used.		Found.	
Sb.	Sn.	Sb.	Sn.
0·2000 gr.	0·2000 gr.	0·2084 gr.	0·1964 gr.
0·2000 ,,	0·2000 ,,	0·2030 ,,	0·2031 ,,
0·3000 ,,	0·3000 ,,	0·3070 ,,	0·3029 ,,
0·5000 ,,	0·5000 ,,	0·5066 ,,	0·5004 ,,
0·5000 ,,	0·5000 ,,	0·5177 ,,	0·4962 ,,

The last two antimony results were corrected for the carbonaceous residue, which was filtered off on a small filter and weighed, being 0·0085 and 0·0070 gr. Following the analogy of the two cases, we may suppose, as J. P. Cooke, jun.,[*] does in his determination of the atomic weight of antimony, that this residue comes from occluded oxalic acid.

A slight modification of Bunsen's[†] method of weighing antimony as antimony tetroxide having given 0 4996 and 0·4986 gr. antimony instead of 0·5000 gr., four separations were made in which the antimony was weighed as antimony tetroxide, the other details remaining as before :—

Used.		Found.	
Sb.	Sn.	Sb.	Sn.
0·5000 gr.	0·5000 gr.	0·5190 gr.	0·4911 gr.
0·5000 ,,	0·5000 ,,	0·5067 ,,	0·4963 ,,
0·5000 ,,	0·5000 ,,	0·5136 ,,	0·4973 ,,
0·5000 ,,	0·5000 ,,	0·5146 ,,	0·4926 ,,

While the results obtained by this method are no better than those obtained by weighing antimony as trisulphide, yet it required less time, and is a much neater operation to get them.

Since reaching the above results and conclusion Bunsen[‡] has published further experiments on this method of weighing antimony, and reaches the conclusion that it cannot easily be done with accuracy, because more oxygen than is necessary will be given off at a temperature only slightly above that required to convert antimony pentoxide into the tetroxide, and at a very intense heat the trioxide thus formed will be volatilised. From my results it would seem that the heat employed was too low rather than too high.

In conclusion, I desire to express my thanks to Prof. O. D. Allen for much kind assistance during the progress of the above work.—*American Chemical Journal.*

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[*] It was observed that when the fluid with the Sb_2S_3 precipitate was allowed to stand to remove H_2S, there was always a separation all through the liquid of flakes which did not look like S, but did look like SnS_2: a supposition supported by the fact that these flakes separated in the filtrate from Sb_2S_3, filtered off immediately as it cooled during filtering, and were dissolved again on applying heat.

[*] *Transactions of Amer. Acad. Sci., Boston*, 13, 15.

[†] *Ann. der Chemie*, 106, 3.

[‡] *Fresenius's Zeitschrift*, 18, 268.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 20, 1879.

Dr. Gilbert, Vice-President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The Chairman announced that a ballot for the election of Fellows would take place at the next meeting of the Society (December 4).

The following certificates were read for the first time:—J. Howard, J. Knowles, J. Snodgrass, A. Scott, E. J. Day, J. Steiner.

The Chairman then called on Mr. Church to read a paper. "*A Chemical Study of Vegetable Albinism* (*Part* II., *Respiration and Transpiration of Albino Foliage*)." The author has proved that white foliage does not possess the power, even in sunshine, of decomposing the carbon dioxide of the air, but adds largely to the normal amount of that gas in the air, thus resembling the petals of flowers and the action of green leaves during darkness. The best results were obtained with the maple (*Acer negundo*), the holly, the ivy, and the *Alocasia macrorhiza*. Every care was taken to choose white and green foliage comparable in every respect, age, &c. The leaf stalks were placed in boiled distilled water, and covered by a bell jar inverted over mercury. To the mouth of this bell jar is fitted a cork, through which pass two tubes, one long and the other short. Air is sucked from the long tube through a Pettenkofer tube containing baryta water. At the end of the experiment the Pettenkofer tube is washed out without exposure to the atmosphere, and the carbonate determined after the method of Dupré and Hake (*Chem. Soc. Journ.*, March, 1879). The CO_2 in the atmosphere was found to be 3·21 parts in 10,000. The author embodies his results in a table. 1000 sq. centimetres of the white foliage of the maple evolved, in two hours, 16·69 parts of CO_2 per 10,000 of air; 1000 sq. centimetres of green foliage evolved 0·44 parts CO_2. Similarly, 1000 sq. centimetres of white holly leaves evolved 18·82 parts CO_2 per 10,000; of green, 4·49. 1000 sq. centimetres of white Alocasia leaves in two experiments evolved 15·06 and 38·96 parts of CO_2 per 10,000; of green, 1·14 parts. The author has also studied the comparative loss and gain of albino and green foliage. White holly sprays placed in water gained, in two hours, 0·29 per cent; green holly, under similar conditions, gains 1·55 per cent. When no water was supplied the white holly lost 0·54 per cent; the green, 10·26 per cent. The author promises further work on this interesting subject. He exhibited some dried specimens of albino and ordinary leaves, the albino leaves being thinner and altogether much less substantial in their structure.

Dr. Gilbert said that the results obtained by the author seemed to be of considerable importance. In a former paper the composition of the green and white leaves had been investigated, the white leaves containing less lime but more non-albuminoid nitrogen than the green, indicating a capability for development without actual growth. In the present paper the author shows that these white leaves do not perform leaf functions.

Mr. Warington remarked that in the white leaves respiration seemed to take place in an exalted state. He would like to know whether much starch had been found in the white leaves?

Mr. Groves asked if there was any difference in the number of stomata in the white and green leaves?

Dr. Voelcker enquired where the large amount of carbonic acid given off by the white leaves came from? The researches seemed to indicate that the white leaves seemed to be partially dead; if not quite deceased, at least gradually decomposing. This would account for the evolution of CO_2.

Mr. Church, in reply, said there was more starch in the green than in the white leaves; that the leaves used in the experiments were all in active growth and not in the least decaying. In his opinion the CO_2 given off by the white leaves came from substances elaborated by the green leaves. In the same way the flowers of the white lily and green leaves in the dark evolved CO_2 without any actual decay. The green leaves gave off CO_2 as well as the white, but in sunshine they decomposed more than they excreted. As far as he knew white and green leaves had the same number of stomata.

Mr. Kingzett then read a paper entitled, "*Contributions to the History of Putrefaction*," Part I. The author discusses to a certain extent the process of putrefaction, and concludes that it would naturally be expected that a substance allowed to undergo putrid fermentation without oxidation would more readily undergo chemical oxidation than the original integral mass, and therefore that the oxygen absorbing capacity of a substance would progess increasingly with such putrefactive decomposition. He therefore endeavoured to determine the oxygen-absorbing capacities of organic solutions from time to time as they passed into putrefaction, and to compare these numbers with the oxygen capacities of similar solutions protected during the same periods by so-called antiseptics. Various difficulties were met with, and the author does not offer all the results obtained. Some of the experiments, however, have an important bearing on Tidy's oxygen process, which, in the words of its author, "undoubtedly furnishes us with exact information as to the relative quantities of putrescent and easily oxidisable matter, and of non-putrescent and less easily oxidisable matters present in the water." The author of the present paper thinks that the oxygen process is liable to mislead chemists in interpreting their results if the most pernicious organic matters are those which are in a putrescent state; for, from the results obtained by Kingzett, it appears that the oxygen absorbed by a water containing organic matter in a non-putrescent condition is more than that required by the same organic matter in a putrescent state. Thus, 5 c.c. of a dilute solution of albumin, which began to stink after 150 hours, required, when fresh, permanganate equal to 0·008004 grm. oxygen; after keeping 24 hours, 0·008671; after 120 hours, 0·0076038; after 1104 hours, 0·00667; after 1176 hours, 0·0062031; after 1440 hours, 0·0058696; after 1534 hours, 0·0054694; showing, after a slight rise (8 per cent), a decrease of over 30 per cent in the oxygen absorbed. Similar results were obtained with extracts of beef, fish, &c. Thus the author concludes that the oxygen process might pass a water containing pernicious products, since it is possible to obtain an organic solution in an active state of putrefaction, which requires less permanganate than the same solution in a fresh state.

Prof. Tidy said that the results obtained by Mr. Kingzett required thinking about. No doubt different materials had different oxygen-absorbing powers. As a practical man he was satisfied with the third place of decimals. He was pleased to see Mr. Kingzett found it necessary to go to the seventh.

Mr. Otto Hehner thought that the results rather proved than disproved the accuracy of the oxygen process, because the oxygen-absorbing power did at first increase; afterwards, of course, substances nitrified, and in other ways the organic matter disappeared. This rise and subsequent decrease he had himself pointed out, using the albuminoid ammonia process.

Mr. Church suggested that some inaccuracy might arise from the deposit which fell as the solution putrefied, the successive quantities of 5 c c. containing less and less organic matter as the deposit increased.

After some remarks by Dr. Voelcker and a brief reply by Mr. Kingzett to the various points raised in the discussion,

The next paper was read by Dr. Wright. It was entitled, "*Notes on Manganese Dioxide*," by C. R. A. WRIGHT and A. E. MENKE. The authors have repeated many of the experiments of former observers with in some cases very different results. They have made many careful gravimetric analyses of the substances precipitated under various conditions, the experiments being more particularly directed to the examination of substances formed in presence of potassium compounds so as to determine how far potash is carried down in combination with the manganese. Substances were prepared by the action of nitric acid or sulphuric acid on potassium permanganate; by solution in hydrochloric acid and reprecipitation by water in presence or absence of potassium salts; by acting on potassium permanganate with sulphurous acid, alcohol, and glycerin; by precipitating manganese salts with potassium permanganate under various conditions; by acting with air and caustic potash on manganese salts (Weldonising); by precipitating from solution by bromine, &c., under various conditions; and by heating manganese nitrate to 160° alone and in the presence of potassium nitrate. In every case except the last potassium was present in the ultimate product in considerable quantity, even though the precipitate was formed in presence of very large quantities of free hydrochloric, sulphuric, nitric, or acetic acid. Other metals if present are often carried down in preference to potassium, *e.g.*, calcium. Unless the circumstances of the experiment are such as to allow of the precipitation of a large percentage of potassium or other equivalent metal, the precipitate never contains as much oxygen as corresponds to MnO_2, the deficiency being greater or less as the quantity of potash present is less or more. The only exception to this rule occurs when hot solution of manganese salt and excess of permanganate act on one another; with cold solutions the precipitate is deficient in oxygen unless zinc sulphate be added. Manganese dioxide containing potash can be completely converted into MnO, retaining but traces of potash by long-continued ignition in a current of hydrogen. The green potash-free oxide thus formed does not spontaneously oxidise in the air. When freshly thrown down and just dry to the sight and touch, the dioxide is a hydrate, $4MnO_2,H_2O$; on standing over sulphuric acid this hydrate loses water indefinitely and continuously. MnO_2H_2O is the lowest hydrate stable in dry air. Up to 108° no appreciable loss of oxygen accompanies the expulsion of water. At 210° all the precipitated oxides, &c,, tried lose oxygen slowly and regularly. The nearly anhydrous MnO_2, prepared by heating manganese nitrate to 160°, does not evolve oxygen at 210°. In all cases perceptible amounts of water from a few tenths to two per cent are retained after many hours drying in a current of dry pure air at 210°. The volumetric processes of Kessler and Pattinson have been examined; they give good results. The authors suggest a convenient modification of Pattinson's method. The diluted solution, slightly acid, is heated to nearly 100°, a considerable excess of bromine water added, and then freshly precipitated zinc carbonate, all free bromine being expelled by boiling; ferric chloride usually forms permanganate, and thus complicates the manipulation. A more convenient and quite as accurate a method as any of those requiring bromine, &c., was found to be the addition of the diluted and not too acid solution of manganese in the cold to a small excess of dilute permanganate solution containing zinc sulphate. The precipitate is collected on a glass-wool funnel, dissolved in excess of acid ferrous sulphate, and titrated as usual. Three-fifths of the manganese in the precipitate represent the manganese in the original solution. The authors have verified the statement of Gorgeu that actual MnO_2 is obtained by heating manganese nitrate to 160°. The statements of Guyard as to the effect of heat on the precipitate formed by adding manganese salts to permanganate are also corroborated. The recent statements of Pickering as to the deficiency of oxygen in the substances thrown down by acting with water on the superchlorides of manganese are also substantially correct. The accuracy of the results of Volhard as to obtaining pure MnO_2 free from potash by precipitating manganese sulphate with permanganate in the presence of nitric acid, &c., is questioned by the authors. The experiments of Morawski and Stingl have not been confirmed as far as they have been repeated, viz., hydrated manganese dioxide containing potash does not (as stated by these chemists) lose all its water by ignition. The substance thrown down by the action of manganese sulphate on potassium permanganate is not $3MnO_22H_2O$, but an indefinite hydrate containing much potash. On boiling with caustic potash it does not form (after washing and drying at 100°) $Mn_4KH_3O_{10}$ or $8MnO_2.K_2O,3H_2O$ as stated, but a substance much richer in potash, $5MnO_2K_2O$. $Mn_4KH_3O_{10}$ does not uniformly result by the action of alcohol, glycerin, &c., on potassium permanganate, but, instead, substances of very variable composition. The authors also notice incidentally that manganese chloride is sensibly volatile at a red heat in a current of HCl, and that perceptible errors in alkali determinations may be introduced if solutions containing ammonium sulphide are evaporated down in glass or porcelain. Identical results were obtained when titrating the available oxygen in a substance, whether the material was dissolved in acid ferrous sulphate checked by dichromate, or was distilled with HCl into KI, and the titrated iodine estimated by adding excess of thiosulphate and titrating back with iodine solution.

The next paper was read by the SECRETARY, "*On the Reaction between Sodium Thiosulphate and Iodine: Estimation of Manganese Oxides and Potassium Bichromate*," by S. PICKERING. In a former paper the author suggested a modification of Bunsen's volumetric method, viz., transferring the sample to be analysed to a beaker containing a large excess of potassium iodide, adding a small quantity of acid, and determining the iodine liberated by running in sodium thiosulphate solution. This method gives results slightly higher than the original method of Bunsen, viz., boiling the oxides with hydrochloric acid, and collecting the evolved chlorine in a solution of potassium iodide. The author has in the present paper exhaustively examined the effects produced by varying the several conditions of the reaction. When iodine and sodium thiosulphate react in warm solution a decomposition,—

$$4I_2+Na_2S_2O_3+5H_2O=2NaHSO_4+8HI,$$

attended with the formation of sulphate occurs, as well as the ordinary reaction, $I_2+2Na_2S_2O_3=Na_2S_4O_6+2NaI$. Thus at 52° 3·9 per cent of iodine reacted to form sulphate; at 0° 1·84 to 0 per cent reacted in a similar manner. Dilution increases very slightly the amount of sulphate formed. An excess of potassium iodide is without effect. Dilute solutions of iodine do not vary in four days as regards the amount of iodine they contain, whether kept in the dark or in diffused daylight. Within certain limits the amount of iodine liberated at once is proportional to the amount of hydrochloric acid added, but the acid has no influence on the relative proportions in which the two above-mentioned reactions take place. No difference occurs whether the reaction is made by adding iodine solution to an excess of thiosulphate or thiosulphate to the iodine; if, however, hydrochloric acid be present the amount of sulphate is increased. The author discusses the various forms of apparatus for estimating the oxides of manganese by Bunsen's plan: he prefers boiling the oxide in a small flask fitted with a thistle funnel, the chlorine being absorbed in three other flasks containing potassium iodide. Traces of chlorine were retained by the acid liquid, even after prolonged boiling. If undiluted acid be used the Bunsen method gives results almost identical with those obtained by using the plan suggested by the author; if the acid be diluted the amount of chlorine evolved is diminished in the Bunsen method. If potassium bichromate be estimated by the Bunsen method a notable deficiency of chlorine is observed, even if the acid be undiluted. If chlorine-water be diluted and boiled considerable loss of chlorine takes place from the formation of hydrochloric acid. This loss begins at low temperatures. This probably is sufficient to explain the low results obtained by the Bunsen method. The author's modification is, of course, not applicable to manganese ores owing to the presence of ferric oxide. Bunsen's method must therefore be used with the precautions above indicated.

The Society then adjourned to December 4, when a ballot for the election of Fellows will take place, and the following papers will be read:—"On the Theory of Fractional Distillation, Part II.," by F. D. Brown; "On the Influences Exerted upon certain Chemical Changes by Variations in the Amount of Water of Dilution," by M. M. P. Muir and C. Slater; "On α- and β-phenanthrene Carbonic Acid," by F. R. Japp; "On some Derivatives of Phenyl-acetic Acid," by P. Philipps Bedson.

PHYSICAL SOCIETY.

Ordinary Meeting, November 22, 1879.

Prof. W. G. Adams in the Chair.

New members:—Prof. Reilly and Prof. Heath, of Cooper's Hill Engineering College.

Prof. Guthrie exhibited a new Image Retention Photometer, and demonstrated its action to the meeting. It consists of two fixed plane mirrors inclined to each other at an angle of 45°. The rays from the two sources of light to be compared are allowed to fall on these mirrors, those from one source, say that on the right hand, falling on the right-hand mirror, and those from the left-hand source on the left-hand mirror. These rays are again reflected from the mirrors at right angles to their former paths, and thrown upon a semi-transparent screen, where their relative intensities can be compared by the eye of the observer. Between the mirrors and each source of light a revolving shutter is interposed. These shutters are formed of brass disks, and they are both mounted on the same axis, which can be turned by hand or otherwise. They would completely screen the light from the mirrors were it not that each is provided with four radial apertures or slots, through which the rays can pass. The slots on the side at which the brighter source of light is placed are narrower than those on which the weaker source is placed. The latter slots are made adjustable in size by sliding blinds, and a scale is added to measure the degree to which they are closed. On revolving the shutters the reflection of the rays to be compared are seen side by side and (owing to the persistence of images on the retina) continuously on the screen placed in front; and they are brought to equality of brightness by closing or opening the blinds of the adjustable shutter. When this is so the ratio of the respective orifices of the shutters as given by the scale is the inverse ratio of the luminous intensities compared.

Prof. Adams remarked that the speed of rotation should be such as to produce a uniform field of light on the screen, a result which hand-turning was not very conducive to.

Prof. Foster observed that the use of this new photometer might be less fatiguing to the eye than those photometers which presented a steady beam to the eye undiluted with intervals of darkness, during which the light is cut off, as in the instrument before the meeting.

Prof. Reinold then read a paper by Prof. Rücker, of the Yorkshire College, Leeds, "*On a Suggestion as to the Constitution of Chlorine offered by the Dynamical Theory of Gases.*" If a gas of density, δ, consists of molecules, each of which possesses m degrees of freedom, and if also the inter-molecular forces are negligable, the specific heats at constant pressure (Cp) and at constant volume (Cv) are connected by the two well-known equations—

$$(1.)\qquad (Cp - Cv)\,\delta = 0·694.$$

$$(2.)\qquad \frac{Cp}{Cv} = 1 + \frac{2}{m+e}.$$

Where e is a quantity which depends upon the potential energy of a molecule. Hence, if Cp is given by experiment, Cv can be calculated from the first equation, and then $m+e$ is known from the second. Regnault determined the specific heats at constant pressures of 35 gases, and from the experiments of E. Weidemann and of Wullner it appears that his values are correct within 6 per cent, and that $m+e$ can be calculated very approximately from the above equations if Cp is given. One of the chief difficulties of the thermo-dynamic theory of gases has been to attribute to m and e values which would at once lead to the observed ratios of Cp and Cv, and satisfy any rational supposition as to the interior mechanism of a molecule. Kundt and Warhng proved that for mercury—

$$\frac{Cp}{Cv} = 1·666,$$

which is consistent only with the supposition that the atoms of mercury are smooth rigid spheres; and Boltzmann and Bosanquet have pointed out that for a smooth rigid surface of revolution—

$$\frac{Cp}{Cv} = 1·4,$$

a number agreeing closely with the experimental values for air, O, N, H, CO, and NO. The molecules of these gases may therefore be constituted of two spheres rigidly united, or, as Mr. Rücker suggests, bound together by forces which prevent the separation of their surfaces while leaving them otherwise free to move. The principal object of Prof. Rücker's paper was to point out an interesting fact connected with the application of this theory to chlorine. The maximum number of degrees of freedom which a molecule composed of smooth n rigid spheres could possess would be $3n$, but the forces in play between the spheres might reduce the number. Thus, the value of $m+e$ could not exceed, but might be less than, $3n+e$. When the molecule consists of two atoms $e=0$, but for more complexer molecules we should, *cæteris paribus*, expect its value to increase with the number of molecules. From two tables of results calculated by him, Prof. Rücker, however, finds that for a number of simple and complex gases and vapours the value of $m+e$ is for each substance less than $3n$ (or the maximum possible value of m), while for the majority of the chlorine compounds examined the reversed statement holds good; that is, the value of $m+e$ is generally greater than $3n$. This difference may be explained by supposing that for chlorine e is abnormally large, and that the spheres are not necessarily in contact; or that n has been taken too small, that the symbol Cl_2 is incorrect, and that the chlorine atom contains a larger number of sub-atoms than has been supposed, a supposition which accords with the recent researches of Prof. Victor Meyer on the vapour-density of chlorine. Prof. Rücker also finds that the ratio of the specific heats of bromine and one of its compounds studied (C_2H_2Br) agrees with those of chlorine and the corresponding chlorine compound.

Dr. Shettle, of Reading, then read a paper on the "*Influence of Heat upon certain forms of Induction Coils, considered more especially in relation to the Inductive Power which the Blood Exercises on the Various Structures of the Body.*" The author found that when a copper and a zinc wire were insulated from each other by parchment-paper and paraffined silk, and wound in close proximity to each other, an (induced) current was indicated on a galvanometer whose terminals were connected to the neighbouring ends of the zinc and copper wires respectively, the other ends being left free. When the latter were connected across the deflection was *nil*. On raising the temperature of the two wires by causing hot water to flow inside the coil into which they were wound the deflection was largely increased. These experiments led Dr. Shettle to imagine that there is a similar action in the animal body. The heart is made up of nerves and muscular fibres winding spirally, and some of these wind round each other so as to form a spiral cord, round which the blood capillaries also wind. Dr. Shettle compares these nerve and muscle bundles to the coils of zinc and copper wire in his experiments, and infers that electric currents may be induced in them as in the wires. The flow of the warm magnetic blood would also tend to produce currents in them. Dr. Shettle, further, drew attention to the fact that animals live and move in a magnetic field, and that electricity must be generated in them by their movements, internal and external.

Mr. Emmott exhibited Crossley's Form of Microphone, which consists of four short rods of carbon jointed loosely into four blocks of carbon, so as to form a square. It is used as a transmitter for telephones, and Mr. Crossley regularly transmits the services of a church with it to several hearers. Its speaking, singing, and whistling powers were successfully demonstrated to the meeting.

CORRESPONDENCE.

CARBON IN STEEL.

To the Editor of the Chemical News.

Sir,—M. Sergius Kern (Chemical News, vol. xl., p. 225), in common, I believe, with most analysts, condemns Eggertz's colorimetric method for the estimation of carbon in steel when accurate results are required, although, judging from the figures he gives, it works in his hands very fairly. M. Kern seems to favour the chromic acid method in cases where strict accuracy is essential; but I should like to ask him if he has ever tried the direct combustion of the steel in a short platinum tube in a stream of oxygen, as recommended by me in a paper read before the Chemical Society in 1870.[*] This method is exact and rapid, the combustion of 2 grms. of steel not requiring more than forty minutes, and the quantity of ferric oxide formed is a check on the completeness of the combustion. For a steel works, where many carbon estimations are required, I should imagine the method to be particularly suitable, as only the boat containing the sample need be changed, and in a series of experiments, made immediately one after the other, one weighing of the potash bulbs would suffice for each estimation after the first.

The chromic acid method as modified by Elliott, involving filtration through asbestos, I found to be tedious, and liable to error.

I append some results obtained by the three processes:—

1.	2.	3.	4.	5.	6.	7.	8.
Eggertz's Method (Mean of several).							
0·283	0·349	0·486	0·587	0·701	0·789	—	1·319
Chromic Acid Method.							
0·349	0·421	0·457	0·670	0·724	0·900	0·943	1·248
—	0·533	0·554	—	—	0·782	0·942	—
—	—	—	—	—	0·734	—	—
Direct Combustion.							
0·273	0·359	—	—	0·649	0·763	0·921	1·180
—	0·359	—	—	0·620	0·759	0·922	1·151
—	—	—	—	—	0·758	—	—

—I am, &c.,

W. Douglas Herman.

St. Helens, Lancashire,
November 17, 1879.

BEHAVIOUR OF CHLORINE AT A HIGH TEMPERATURE.

To the Editor of the Chemical News.

Sir,—After reading the letter published in your impression of November 14 (vol. xl., p. 232) from Prof. Victor Meyer to Dr. Endemann, I immediately wrote to my friend, Prof. Meyer, and have just received the following reply from him, and as it is written in English, I can give it verbatim.

"Zürich, November 20, 1879.

"My Dear Mr. Watson Smith,

"In reply to your kind letter of the 15th November, I beg to inform you that the following statement, made by me to Dr. Endemann and printed in the Chemical News of the 14th of November:—'That the communications of the English journals; which refer to the obtaining of oxygen from chlorine, were published without my knowledge and against my wish,' refers to the article 'Decomposition of Chlorine' (Chemical News, 15 Aug., 1879), and to the communication of Sir B. C. Brodie (*Journal of the Chemical Society*, No. 202, Sept., 1879, p. 679.) But I did not in the least have in view your article (Chemical News, 1st August, No. 1027, p. 49), the contents of which, as far as my researches are concerned, have met with my full approval.

"Sincerely yours,
"Victor Meyer."

It is possible some misunderstanding might have arisen had my position, with regard to the publication of the article under the title heading this communication, been left at all in question.—I am, &c.,

Watson Smith, F.C.S., F.I.C.

The Owens College, Manchester,
November 24, 1879.

Decomposition of Chlorine.—Mr. Frederick Barkas, of the Zurich Polytechnikum, writes as follows:—A most important chemical discovery has just been made by Herren Victor and Carl Meyer, of the Polytechnikum, Zurich. Herr Victor Meyer had been making a number of experiments to determine the vapour-densities of some organic compounds whose constituents were doubtful. Having invented a new and simple apparatus for the purpose, in order to determine its accuracy he made several experiments to test the vapour-density of the commoner elements—oxygen, &c.—at temperatures from 100° C. (boiling water) to 1567° C. (heat given by a gas furnace). At length he tried chlorine, which gas was obtained by heating pure dry bichloride of platinum, but the results were not in accordance with theory. When the gas was heated at temperatures under and up to 620° C. it gave a vapour-density 2·46, while theory gives 2·45. This was very good; but at 808° C. the density was only 2·20. At 1028° C. it gave 1·87, while at from 1242° C. to 1567° C. the density remained nearly constant at 1·64 average. From this it was to be inferred that two molecules of chlorine at temperatures above 1200° C. break up into three molecules. Next came the question, Does this arise from an alteration of the molecular constitution of chlorine, or from an actual decomposition into some new gases; in other words, is chlorine an element? Thereupon the expanded chlorine gas was slowly caused to stream into a fluid that absorbs chlorine. Potassa, iodide of potassium, and mercury were all used for the purpose, and with the same result—a gas accumulated in the measuring tube that was not chlorine, but oxygen. Chlorine was thereby proved to be not an element, but an oxide of some new element. A number of careful investigations were then made to be sure that the chlorine used was absolutely pure and dry, but with the same result. The new element, hypothetically called *Murium*, has not yet been isolated, but the learned professors are carrying out the important investigation with all diligence, so that doubtless within the course of a few weeks we shall hear more of the new element, *Murium*. That chlorine is an oxygen compound is not altogether a new idea. Sir Humphry Davy, after his celebrated discoveries of the compound nature of soda and potassa, surmised that chlorine, iodine, and bromine were likewise oxygen compounds.—*Journal of the Franklin Institute*, November.

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[*] *Jour. Chem. Soc.* [2], viii., 375.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 18, November 3, 1879.

Abnormal Spectrum of Light.—M. de Klercker.—The anomaly in the spectral position of the various luminous rays, produced when the light is dispersed by the solutions of certain colouring-matters, has for some years attracted the attention of physicists. From his experiments the author concludes that the abnormal luminous spectrum is composed of two parts entirely distinct, and due, doubtless, to the different magnitude of the retardation produced by the molecules of different kinds contained in the solution.

Stomachic and Duodenic Digestion: Action of the Pancreatin.—Th. Defresne.—Hydrochloric acid in the gastric juice is combined with an organic base, which moderates its action and changes its properties. Under this influence pepsic digestion is comparable to that which takes place in the stomach. The acidity of the mixed gastric juice, after half an hour of ingestion, is not due to leucin hydrochlorate, but to the lactic, sarcolactic, tartaric, and malic acids.

Ultra-violet Absorption Spectra of the Nitric and Nitrous Ethers.—J. L. Soret and A. A. Rilliet.—Ethyl, butyl, and amyl nitrates absorb energetically the ultra-violet rays. The action of amyl and ethyl nitrites is very similar. The spectrum of these ethers in an alcoholic solution is particularly interesting in the solar light.

A New Stellar Spectroscope.—L. Thollon.—Not susceptible of useful abstraction.

Vapour-tension of Saline Solutions.—F. Pauchon. The value of *a* (one of the coefficients drawn from the author's experiments) in case of potassium and sodium chlorides and sodium nitrate and sulphate increase with the quantity of salt dissolved, whilst in case of sodium nitrate and sulphate it increases.

An Electro-capillary Thermometer.—E. Debrun.—The principle of the apparatus is as follows:—In a Lippmann's electrometer any mechanical action which modifies the form of the mercurial meniscus determines an electric action capable of giving rise to a current whose force is proportional to the mechanical action exerted.

Animal Cellulose or Tunicin.—M. Franchimont.—The difference between animal cellulose and that of plants, if it exists, cannot be attributed to a difference of the groups $C_6H_{10}O_5$. It depends upon a different degree of polymerisation, or a more intimate isomerism.

Researches on the Different Modes of Combination of Phosphoric Acid in the Nervous Substance.—L. Jolly.—Phosphoric acid exists in a phosphoro-conjugated state, the acid becoming free after ignition and in combination with potassium, calcium, magnesium, and iron.

No. 19, November 10, 1879.

The Thermic Absorbent and Emissive Powers of Flames and the Temperature of the Voltaic Arc.—F. Rosetti.—The transparence of flames is very great, and they exert a very feeble absorption upon the thermic radiation by which they are traversed. The transparence diminishes and the absorption increases proportionally if the thickness of the flame increases. The absolute thermic emissive power of white flames produced by coal-gas is equal to unity, whilst the absolute thermic emissive power of the pale blue flames of a Bunsen burner may be expressed by 0·3219. The voltaic arc has a much lower absorptive power. The maximum intensity for the positive extremity of the carbon is about 3900°, that of the negative extremity being only 3150°. The temperature of the arc between these two extremities is about 4800°, whatever may be the thickness of the arc and the intensity of the current.

Reseaches on the Passivity of Iron.—L. Varenne.—The author has observed that iron, rendered passive, if subsequently plunged into ordinary nitric acid and struck against the sides of the containing vessel, is dissolved at once, the weaker the acid the smaller is the force of the blow required. Passive iron is completely immersed in dilute acid, and then removed with caution so that it is completely covered with the acid and suspended in the air. After a few moments, almost immediately, in a brisk current of air the attack begins and is continued with energy. If passive iron is plunged into dilute nitric acid, and some bubbles of air are allowed to pass near the metal, the reaction begins. The iron during its passive state is coated with a gaseous covering, which appears to consist of nitrogen binoxide. The author purposes the further investigation of these phenomena.

Alcoholic Fermentation.—M. Cochin.—The author concludes, in opposition to M. Berthelot, that yeast does not give rise to a soluble alcoholic ferment.

Additional Note on the Calcination of the Dregs of Beet-root.—C. Vincent.—The author contraverts the charges urged against his process by MM. Duvillier and Buisine (*Comptes Rendus*, lxxxix., p. 48, 1879).

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 12, 1879.

Synthesis of Phenyl-naphthalin.—Watson Smith.—A preliminary communication. The author passed a mixture of mono-brom-naphthalin and benzol both through an empty ignited tube and through one filled with soda-lime. In the second case there were formed some diphenyl and a considerable quantity of naphthalin. In the first case there appeared a little resinous matter, and an escape of hydrobromic acid gas.

Action of Oxalic Acid upon Carbazol.—W. Suida.—The product is a blue substance, soluble in cold concentrated sulphuric acid with a pure blue colour. The original compound is not separated out on the addition of water. The authors have applied to their product the name ortho-amido-phenyl-benzoic acid.

Hydratation of Terpen.—F. Flawitzky.—A preliminary communication.

Salt of Roussin.—O. Pawel.—The author considers that for this salt four rational formulæ are possible. The different statements concerning its composition are due to the fact that Roussin, Rosenberg, and Demel examined an impure decomposed mixture of potassium and ammonium salt.

Six Lecture Experiments.—C. von Thann.—These experiments cannot be intelligibly described without the accompanying engravings.

Constitution of Alizarin Blue.—C. Graebe.—The author considers that the formation of alizarin blue depends on the production of quinolin.

Action of Ammonia upon Sulpho-anthraquinonic Acids.—R. Bourcart.—The author obtained a compound corresponding in composition to that of an amido-oxy-anthraquinon. Bisulph-anthraquinonate of soda, resembling iso-purpurin, if heated with ammonia, yields a nitrogenous acid.

Action of Antimony Trichloride and Bismuth Trichloride upon Aromatic Hydrocarbons: Characteristic Colour Reactions.—Watson Smith.—With antimony trichloride chemically pure naphthalin gives no colouration; if traces of impurities are present a crimson colouration is produced. Anthracen added in minute traces to the melted trichloride, gives a greenish yellow colour. On cooling there are formed colourless needles of an addition product of anthracen and antimony trichloride, which appears to be characteristic of anthracen. Phenanthren dissolves in the chloride less readily than anthracen, and gives a faint greenish colour. Diphenyl and the three isomeric dinaphthyls give no colour. Stilben if mixed with the chloride at a very gentle heat gives an orange colour, which disappears if more strongly heated. The author has examined the reactions of many other bases, natural and artificial, both with antimony and bismuth trichloride.

Congealing Point of Bromine.—J. Philipp.—Pure bromine solidifies between −7·2° and −7·3°.

New Method of Preparing Sulphodilactic Acid.—C. Böttinger.—The author obtains this acid by the action of hydrogen sulphide upon potassium pyruvate.

Behaviour of Chlorine at High Temperatures.—V. and C. Meyer.—The molecules of oxygen, nitrogen, and sulphur at 1567° still retain the molecules commonly ascribed to them, O_2, N_2, S_2. The dissociation of chlorine begins somewhat above 620°; between 800° and 1000° intermediate numbers are obtained, but from 1200° upwards the density becomes constant again, amounting to exactly two-thirds of the value calculated for Cl_2. It is therefore proved that the molecular weight of chlorine, which is 71 up to 600°, above 1200° is reduced to 47·3. Iodine shows similar phenomena.

On a Base Discovered in Fusel Oil.—H. Schrötter.—The body in question is a liquid which distils over between 180° and 230°, but appears to be a mixture of at least two compounds.

Oxidation Products from Cymol-sulphide.—L. B. Hall and Ira Remsen.—An examination of the derivatives of sulph-amin-para-toluylic acid.

Anhydro-sulph-amin-isophthalic Acid.—Ira Remsen and R. D. Coale.—The authors conclude that the sulphamin group and the carboxyl group cannot co-exist in the same ortho position.

Para-oxyphenyl-acetic Acid.—H. Salkowski.—This acid, $C_8H_8O_2$, is produced during the putrefaction of horny matter. The author describes its reactions and some of its salts.

Abietic Acid.—O. Emmerling.—After a historical introduction the author describes the behaviour of this acid with bromine, zinc chloride, hydriodic acid, and with oxidising agents.

Remarks on M. Demel's Memoir on the Arseniates of Zinc and Cadmium.—H. Salkowski.—The author considers that M. Demel is acquainted with an earlier memoir of his on the same subject.

Carbonic Acid Derivatives of Isomeric Toluydins.—J. Cosack.—A brief notice of para-tolyl, meta-tolyl, and meta-ditolyl urea, and of ortho-tolyl-urethan.

Formation of Hydro-para-cumaric Acid from Tyrosin.—E. Baumann.—An account of the decomposition-products of tyrosin, and of the properties of hydro-para-cumaric acid.

Composition of "Weldon Mud" and Similar Compounds.—J. Post.—The proportion of manganese dioxide to calcium, potassium, &c. ("basis," as Weldon terms it), is much less favourable than would appear from Weldon's and Gorgeu's statements.

Influence of the Nitro and Amido Groups upon a Sulpho Group Newly Introduced into the Benzol Molecule.—J. Post.—Not susceptible of useful abstraction.

Compounds of Benzo-trichloride with Phenols and Tertiary Aromatic Bases.—O. Dœbner.—The author describes benzaurin, a colouring-matter prepared from benzo-trichloride and phenol; its reduction to di-oxy-triphenyl-methan, its combination with acetic anhydride, and its decomposition by melting potassa.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 9, October 30, 1879.

M. le Compte du Moncel, referring to the announcement of M. Peltat's researches on the action of sunlight upon galvanic batteries, points out that similar results were obtained by himself (*Comptes Rendus*, Nov. 4, 1872).

A certain M. X., suffering from asthma, is said to have used carbonic oxide with good effect to alleviate the paroxysms.

Theory of Sleep.—E. Fournié.

Practical Means of Ascertaining and Preserving the Good Qualities of Meat.—The evils resulting from an imperfect extraction of blood from the carcases of slaughtered animals is pointed out.

Chemical Researches on Ligneous Papilionaceæ—P. Fliche and L. Grandeau.—Already noticed.

Telephone of M. Gower.—From an English source.

Application of Electricity in Subduing Vicious Horses.—M. Sidot.

Treatment of Sewage.—M. Coquerel.—The sewage is mixed with a reagent—not specified,—the solids are separated in the form of cakes by means of a filter-press, and the press-liquor is treated with lime in order to obtain ammonia.

Quantitative Separation of Manganese from Iron.—MM. Beilstein and Jawein.—From the *Berichte der Deutsch. Chem. Gesells.*

New Method of Producing Hyponitrous Acid and Hydroxylamin.—W. Zorm.—From the same source.

New Organic Acid Contained in Agaricus Integer.—W. Thörner.—From the same source.

Purification of Water, holding in Suspension Organic Matter.—K. and Th. Müller.—This invention, secured by a German patent, consists in the use of milk of lime, followed up by carbonic acid!

Surgical Use of Compressed Air.—An anæsthetic process depending on the use of nitrous oxide mixed with oxygen and applied under pressure.

No. 10, November 6, 1879.

Agricultural operations have been carried on in the park of Noisiel by electric power.

The True Theory of the Phenomena of Interference, of Fresnel.—H. F. Weber.

Measurement of the Focal Distances of Strongly Convex Lenses.—J. Oudemans.—Mathematical papers not susceptible of useful abstraction.

Nickel Baths for Galvano-plastic.—E. Weston.—The addition of boracic acid, free or combined, prevents the formation of a subsalt of nickel at the cathode.

Oxyhydric Lamp of M. Dubosc.—The oxygen is allowed to escape from three apertures instead of one only. The apparatus is adapted for lecture rooms, theatres, &c.

Division of the Electric Light.—M. Lontin.—It seems to be believed that the electric light loses much by being divided. The author gives a case where the totalities of light obtained from 3 burners = 261 carcels; from 4=316; from 5, 305; from 6, 414; after which a regular decrease was observed.

Opposition between the Scholastic System and Modern Chemistry as regards the Chemical Constitution of Bodies.—The first portion of a lengthy memoir, in which the author seems to aim at the rehabilitation of the scholastic philosophy.

Chemical Society Research Fund.— Dr. Warren De la Rue, F.R.S., has just sent to the above fund a third donation of £100, the whole amount to be devoted to a single research.

NOTES AND QUERIES.

Action of Liquor Ammonia on Brass.—In the Chemical News, vol. xl., p. 236, I see a letter from Mr. John Y. McLellan, in which he mentions some observations he has noticed as to the action of liquor ammonia on brass, and which he implies are not as yet on record. But on referring to Vol. v. of "Gmelin's Chemistry," he will find that "Cupreous Oxide with Ammonia" is described as a colourless liquid which gradually turns blue on exposure to the air. This absorption of oxygen, by the above-mentioned, has, as is well known, been employed for the rapid estimation of oxygen by the inventor of that very convenient apparatus sold by Messrs. Mawson and Swan, of Newcastle-on-Tyne.—Arthur Habershon.

MEETINGS FOR THE WEEK.

Monday, Dec. 1st.—Medical, 8.30.
—— Royal, 4. (Anniversary.)
—— Royal Institution, 5. General Monthly Meeting.
—— London Institution, 5.
—— Society of Arts, 8. (Cantor Lecture). "Chemistry of Bread and Bread Making," Dr. Graham.
Tuesday, 2nd.—Civil Engineers, 8.
—— Zoological, 8.30.
Wednesday, 3rd.—Society of Arts, 8.
—— Meteorological, 7.
—— Geological, 8.
—— Pharmaceutical, 3.
Thursday, 4th.—Chemical, 8. Ballot for new Fellows. "On the Theory of Fractional Distillation," Part II., F. D. Brown. "On the Influence exerted upon certain Chemical Changes by Variations in the amount of Water of Dilution," M. M. P. Muir and Chas. Slater. "On α- and β-Phenanthren Carbonic Acid," Dr. Japp. "On some Derivatives of Phenyl-acetic Acid," Dr. P. Phillips Bedson.
Friday, 5th.—Geologists' Association, 8.

TO INVENTORS AND PATENTEES.

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THE CHEMICAL NEWS.

Vol. XL. No. 1045.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 256.)

I shall show further on, and it can be seen from the accompanying tables, that relations of this kind can be drawn up for *all the elements*, showing that there is an intimate dependence between their properties and their atomic weights.

We could have foreseen this by means of the atomic theory, because the atomic weight forms one of the variable magnitudes which determine the functions of atoms. A similar consideration led me to discover the above-mentioned dependence, and this is the reason why I mention it here.

From the preceding, as well as from other relations that I have succeeded in finding, it results that all the functions which show how the properties depend on the atomic weight are periodic functions. First, the properties of elements become modified as the atomic weights increase; then they repeat themselves in a new series of elements, *a new period*, with the same regularity as in the preceding series. The periodic law can therefore be formulated in the following manner:—*The properties of simple bodies, the constitution of their compounds, as well as the properties of these last, are periodic functions of the atomic weights of elements.*

We now pass on to the manner of finding out the function which shows us this dependence; to effect this we should begin by finding the length, or, in better words, the number of members in a period. As for expressing this function, it appears of its own accord in some cases (such as the forms of oxidation); in other cases, there are not up to the present time any means of measuring it exactly, but, nevertheless, it keeps its periodic character.

Already the above-mentioned relations have brought to light the existence and the properties of a period of *seven* elements, corresponding to the period Li, Be, B, C, N, O, F. Let us call it the *small period* or *small series*. If H is attributed to the first series, Li, &c., will belong to the second, Na...... to the third, and so on.

However, all the elements known up to the present time do not belong, as might be believed, to the little series, and, what is still more important, there exists between the corresponding members of the odd and even series (the first two excepted, as will be seen further on) a very marked difference, while the members of the odd or even series show a greater analogy between themselves. An example will prove this sufficiently.

4th series ..	K	Ca	—	Ti	V	Cr	Mn
5th series ..	Cu	Zn	—	—	As	Se	Br
6th series ..	Rb	Sr	—	Zr	Nb	Mo	—
7th series ..	Ag	Cd	In	Sn	Sb	Te	I

The members of the fourth and sixth series show a greater analogy amongst themselves than they do with the members of the fifth or seventh series. Among the members of the even series there are no metalloids so marked as in the odd series; the last members of the even series resemble in many respects (as the forms of lower oxidation) the first members of the odd series. It is thus that Cr and Mn resemble Cu and Zn in their basic oxides. On the other hand, there are marked differences between the last members of the odd series (haloids), and the first members (metals of alkalies) of the even series which follow them. But at the same time, between the last of the even series and the first of the odd are arranged in order according to their properties and atomic weights, *all* the elements which cannot find room in the small periods. It is in this manner that Fe, Co, and Ni in placing themselves between Cr and Mn, on the one side, and Cu and Zn, on the other, form the following series of transition:

Cr=52; Mn=55; Fe=56; Co=59; Ni=59; Cu=63; *Zn*=65.

In the same manner as Fe, Co, and Ni follow the fourth series, Ru, Rh, and Pd follow the sixth, and Os, Ir, and Pt the tenth. These two series (one even and one odd) with the intermediate series of elements, which have just been named, form a large period comprising seventeen members. As the intermediate members (such as Fe, Co, Ni) do not correspond to any of the seven groups of the small period, they form an independent group (the eighth); the members of this group—

Fe = 56; Ni = 59; Co = 59
Ru = 104; Rh = 104; Pd = 106
Os = 193? Ir = 195? Pt = 197

are analogous between themselves, in the same manner as the corresponding members of the even series; such as V, Nb, Ta or Cb, Mo, W, &c., This analogy is derived from the following facts:—

1st. The metals of the eighth group are all of a grey colour, and are difficultly fusible. The fusibility increases from Fe to Co and to Ni; from Ru to Rh and to Pd; from Os to Ir and to Pt.

2nd. These metals possess, even compared with the neighbouring members, very low atomic volumes; for example, the atomic volume of Cr=7·6, of Mn=7·0, of Fe=7·2, of Co=7·0, of Ni=7·0, of Cu=7·2, of Zn=9·2. The volume of Mo=11·2, whilst the volumes of Ru, Rh, and Pd are approximately 9, that of Ag is 10·3, that of Cd 13·0; the volumes of Os, Ir, and Pt are about 9·5, and of W 10·1; that of Au is 10; and, lastly, that of Hg is 15. The smallness of volumes, or of the distances between the atomic centres, render the metals of the eighth group difficultly fusible, leaves them only a small amount of chemical energy, and also determines other properties.

3rd. These metals possess in the highest degree the power of condensing and abandoning oxygen, as has been shown for Ni, Pd, Fe, and Pt by Graham and Raoult.

4th. Their highest forms of oxidation are either bases or acids of such a feeble character that they are easily transformed into lower oxides with a more marked basic character.

5th. In this group we only meet with metals whose form of combination is RO_4 or R_2O_8, such as OsO_4 and RuO_4;* (it is for this reason that these metals have been collected together in a special group.) We notice that in each series the highest oxides capable of being formed by the metals from Fe to Cu, from Ru to Ag, from Os to Au, contain less and less oxygen. The highest oxide of iron is FeO_3; of cobalt, CoO_2; of nickel, Ni_2O_3. In the same manner, osmium gives us OsO_4; iridium with difficulty forms IrO_3; platinum will only give PtO_2; and gold, Au_2O_3.

6th. They give stable alkaline double cyanides. Fe, Ru, and Os give combinations analogous to K_4RCy_6; Co, Rh, and Ir form salts whose composition is according to the formula K_3RCy_6; Ni, Pd, and Pt give salts according to the general formula K_2RCy_4.

7th. They form stable ammoniacal compounds, and resemble one another in many respects. For example, Claus has prepared salts of rhodium and of iridium, which correspond to the roseo-salts of cobalt, $RX_3,5NH_3$, such as $RhCl_3,5NH_3$.

8th. Some forms of combination of these metals, particularly the higher forms, are distinguished by their characteristic colours, &c.

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* Ferric acid would apparently be FeO_4?

TABLE I.

TYPICAL ELEMENTS.			LARGE PERIODS.				
			K = 39	Rb = 85	Cs = 133	”	”
			Ca = 40	Sr = 87	Ba = 137	”	”
			”	? Yt = 88 ?	? Di = 138 ?	Er = 178 ?	”
			Ti = 48 ?	Zr = 90	Ce = 140 ?	La = 180 ?	Th = 231
			V = 51	Nb = 94	”	Fa = 182	”
			Cr = 52	Mo = 96	”	W = 184	Ur = 240
			Mn = 55	”	”	”	”
			Fe = 56	Ru = 104	”	Os = 195 ?	”
			Co = 59	Rh = 104	”	Ir = 197	”
			Ni = 59	Pd = 106	”	Pt = 198 ?	”
H = 1	Li = 7	Na = 23	Cu = 63	Ag = 108	”	Au = 199 ?	”
	Be = 9·4	Mg = 24	Zn = 65	Cd = 112	”	Hg = 200	”
	B = 11	Al = 27·3	”	In = 113	”	Tl = 204	”
	C = 12	Si = 28	”	Sn = 118	”	Pb = 207	”
	N = 14	P = 31	As = 75	Sb = 122	”	Bi = 208	”
	O = 16	S = 32	Se = 78	Te = 125 ?	”	”	”
	F = 19	Cl = 35·5	Br = 80	I = 127	”	”	”

TABLE II.

SERIES.	GROUP I.	GROUP II.	GROUP III.	GROUP IV.	GROUP V.	GROUP VI.	GROUP VII.	GROUP VIII.
	R_2O	RO	R_2O_3	RH_4 RO_2	RH_3 R_2O_5	RH_2 RO_3	RH R_2O_7	RO_4
1	H=1	”	”	”	”	”	”	
2	Li=7	Be=9·4	B=11	C=12	N=14	O=16	Fl=19	
3	Na=23	Mg=24	Al=27·3	Si=28	P=31	S=32	Cl=35·5	
4	K=39	Ca=40	— =44	Ti=48	V=51	Cr=52	Mn=55	Fe = 56; Co = 59 Ni = 59; Cu = 63.
5	(Cu=63)	Zn=65	— =68	— =72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	— =100	Ru=104; Rh=104 Pd =106; Ag=108.
	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	I=127	
	Cs=133	Ba=137	?Di=138	?Ce=140	”	”	”	
	”	”	”	”	”	”	”	
	”	”	?Er=178	?La=180	Ta=182	W=184	”	Os=195; Ir =197; Pt =198; Au=199.
	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	”	”	
12	”	”	”	Th=231	”	Ur=240	”	” ” ” ”

Above are two tables in which will be found supplementary particulars about what has been already said. In the first the elements are placed in *large periods*, with their atomic weights. In the second they are arranged in groups and series, that is to say, in small periods, in such a manner that the differences between the odd and even series become very apparent.

Observations on Table I.—For the sake of brevity the atomic weights have been given in these tables in round numbers, because in the greater number of cases we cannot be sure of the exactitude of the tenths nor of the units. A point of interrogation (?) *before* the symbol of an element means that the incomplete state of the researches on that element do not allow us yet to give it a determinate position in the system. A point of interrogation *after* the atomic weight indicates that in respect to the atomic weight of that element we are still in doubt; or, in other words, the equivalent of the element does not appear to have been fixed exactly up to the present day. Some atomic weights have been modified in the table according to the periodic law (see chapter 5). Thus the atomic weight of tellurium is put at 125 ? which is in accordance with the periodic law, and not 128, as found by Berzelius and others.

Observations on Table II.—In this table the groups are indicated by Roman figures. The seven first groups correspond to the seven members of each series; the eighth group has been already characterised (see above). Cu, Ag, and Au have been placed in the eighth group, because of their analogous properties; they could also have been put in the first group, because of their forms of lower oxidation. The first two series have been separated from the others, for reasons which will be explained later on. They are *typical* series.

(To be continued.)

ON A NEW METHOD FOR THE SEPARATION OF NICKEL AND COBALT.

By M. PH. DIRVELL.

THIS method is founded on the following facts:—

1. If there be added to the aqueous solution of cobalt nitrate or sulphate, an excess of a cold saturated solution of phosphorus salt, mixed with a solution of ammonium bicarbonate from which no ammoniacal odour is emitted, a bluish precipitate is formed in the liquid. When the mixture is slowly warmed the equivalent of carbonic acid in excess at first escapes; then, by boiling for a few seconds, a very distinct ammoniacal odour is perceptible. At this moment the boiling is discontinued, and from 2 to 3 c.c. of ammonia added to the liquid. The precipitate is, for the most part, dissolved, and it is only necessary to warm gently to 100° to obtain a precipitate of a beautiful purple inclining to violet, which is rapidly deposited. Analysis assigns to this precipitate the formula $NH_4O,2CoO,PO_5+2HO$. It loses no ammonia at 110°, and is transformed at a red heat into pyrophosphate, $2CoO,PO_5$.

2. A solution of the corresponding salts of nickel, treated in the same manner, gives only a pure blue liquid, which is not rendered turbid by heat.

3. By mixing the two above-mentioned reagents in excess with a solution containing cobalt and nickel, and treating in the same manner, the red precipitate of ammonio-cobaltic phosphate is again obtained, whilst the remaining blue liquor contains the whole of the nickel. By this means the cobalt in the nickel sulphate of commerce can be detected.

I find it better to make this separation for the qualitative research of the two metals in assay flasks, where evaporation is slow. For the quantitative separation I prepare my reagents in the following manner:—1·30 grms. of phosphorus salt are digested in the cold in 250 grms. of water; 2·30 grms. of effloresced carbonate of ammonia are dissolved in the same quantity of water, and the solution saturated with carbonic acid till all ammoniacal smell is gone.

After having separated the two oxides in the customary way, and having reduced them by hydrogen, they are weighed, dissolved in nitric acid, and the acid solution evaporated to dryness, in a water-bath. The residue is re-dissolved in about 50 c.c. of water, to which is added a quantity of phosphorus salt equal to thirty times the weight of the two metals, and to which a volume of ammonium bicarbonate equal to that occupied by the phosphate has previously been added. We then operate as has already been indicated, care being taken to frequently shake the flask containing the liquid, especially after the addition of the ammonia.

If the boiling has inadvertently been too prolonged, causing the evaporation of the blue liquid containing the nickel on the sides of the vessel, and the consequent precipitation of a little nickel, it is easily ascertained by the colour of the cobalt precipitate, which will, in this case, be paler. It can also be compared with the moist ammonio-cobaltic phosphate, which is kept in a bottle to act as a test. In this case the clear blue liquor is drawn off, the red precipitate dissolved in only as much dilute phosphoric acid as is absolutely necessary (it is even better to leave a little precipitate undissolved), then the operation is continued with ammonium bicarbonate and ammonia.

In all cases the precipitate is washed in cold water, weighed on a tared filter at 100°, or calcined; 100 parts of the calcined precipitate contain 40·4 of cobalt. With regard to the blue liquid separated by filtration, sulphuretted hydrogen completely precipitates the nickel. The precipitate is calcined in a crucible with some sulphur and weighed in the state of sulphide.

This method is an exceedingly rapid one, for the separation requires only one or two hours at the most.*

In conclusion I would say that nickel sulphate now prepared with garnierite is found to contain magnesia, which affects the cobalt precipitate if the separation from that salt is attempted.—*Comptus Rendus*, November 24, 1879.

Production of Nitrous Acid on the Neutralisation of Opposite Electricities.—Prof. Böttger.—This phenomenon ensues both in dry and in moist air. It was formerly supposed that in the latter nitric acid alone was formed.—*Polyt. Notizblatt*, xxxiv., 334.

RESEARCHES ON THE ACTION OF ORGANIC SUBSTANCES ON THE ULTRA-VIOLET RAYS OF THE SPECTRUM.

Part III. On Examination of Essential Oils.*

By W. N. HARTLEY, F.R.S.E., &c.,
Professor of Chemistry in the Royal College of Science for Ireland, Dublin, and
A. K. HUNTINGTON, Fel. Inst. Chem., F.C.S.,
Associate of the Royal School of Mines.

Much chemical and physical research by various investigators has been devoted to the class of bodies known as Essential Oils; as, for instance, the work of Dr. J. H. Gladstone (*Journal of the Chemical Society*, vol. xviii., p. 1; vol. xxiii., p. 147; vol. xxv., p. 1); of Dr. C. R. A. Wright (*Journ. Chem. Soc.*, vol. xxvi., pp. 549 and 686; vol. xxvii., pp. 1, 317, and 619, "Isomeric Terpenes and their Derivatives"); and of Dr. W. A. Tilden (*loc. cit.*, vol. xxviii., pp. 514 and 1258); as well as of many others.

The new method of research employed by us, and described in a Paper about to be published in the *Philosophical Transactions*, has been applied to the examination of these substances. We have to acknowledge the kindness with which several gentlemen have supplied us with samples of essential oils, namely, Dr. Gladstone, Mr. Farries (of the firm of Burgoyne, Burbidges, Cyriax, and Farries), Dr. Septimus Piesse, and Dr. W. A. Tilden.

As in our previous experiments (Abstracts of Parts I. and II. *Proc. Roy. Soc.*, No. 192, 1879), photographs were taken of the spectrum transmitted by the undiluted liquid, and then of that transmitted by the liquid in various states of dilution, the dilutions ranging in some cases from 1 in 50 to 1 in 500,000 volumes of alcohol.

The following is a list of substances examined, classified according to the optical properties they were found to possess:—

Oils and Hydrocarbons transmitting Continuous Spectra

Australene, from oil of turpentine.
Birch bark.
Cajputene dihydrate.
Carraway hydrocarbon, (No. 2).
Calamus.
Citron.
Citronella.
Cedar wood.
Cedrat hydrocarbon.
Cubebs.
Elder.
Hesperidene, from oil of orange-peel.
Indian Geranium.
Juniper.
Lavender.
Lign-Aloes.
Melaleuca Ericifolia.
Menthol, from oil of mint.
Nutmeg hydrocarbon.
Patchouli, oil of (Nos. 1 and 2).
Rose, otto of.
Rosewood.
Rosemary.
Santal wood.
Terebene.
Terebenthene.
Vitivert.

Hydrocarbons showing the Absorption-Bands of Cymene.

Thyme.
Lemon.
Nutmeg.
Carraway (No. 1).

Substances showing Strong Bands of Absorption in the Spectrum transmitted by Dilute Solutions.

Oils of Aniseed.
,, Bay.
,, Bergamot.
,, Bitter Almonds.
,, Cassia.
,, Cloves.
,, Peppermint.
Oils of Pimento.
,, Thyme.
Carvol, oxidised derivative of carraway oil.
Myristicol, the same from nutmeg oil.
Patchouli, blue oil of.

For the most part these latter substances are known to contain the aromatic nucleus as an essential part of their

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* M. Pisani, in whose laboratory this work was done, was kind enough to submit it to some analytical experiments, and he discovered that ammonium acetate could be substituted for the bicarbonate. The acetate is very simply prepared by saturating acetic acid at 8° with ammonia Only 2 c.c. of this acetate is added, 0·050 grms. of cobalt, and 5 c.c. of the solution of microcosmic salt, prepared in the manner already indicated. In order to estimate the various quantities of cobalt in the solutions containing the two metals we rely on the following:—A rose solution contains an excess of cobalt as compared with nickel; a brown solution, half of cobalt and half of nickel; a dirty green liquid, 1 of cobalt to 3 of nickel; and a green solution, 1 of cobalt to 4 of nickel. In the first case, the acetate and phosphate are added as if all was nickel; in the last as if the liquid contained only a fourth part of nickel. After having heated the mixture of metals, phosphate and acetate, for a few moments in the water-bath, it is mixed with a little ammonia, and again heated in the water-bath. At the end of a quarter of an hour the cobalt is precipitated. In cases where the precipitate has not the desired tint it is again treated as indicated above.

* Abstract of Paper read before the Royal Society, November 20 1879.

constitution. Thus the oils of bay, pimento, and cloves contain the substance eugenol, or—

$$C_6H_3.OH.OCH_3.C_3H_5\,;$$

oil of cassia consists of cinnamic aldehyd,—

$$C_6H_5.C_2H_2.COH\,;$$

oil of aniseed of anethol, $C_6H_4.OCH_3.C_3H_5$; and oil of thyme contains thymol, $C_6H_3.OH.CH_3.C_3H_7$, as well as much cymene, $C_6H_4.CH_3.C_3H_7$.

Some other oils, such as bergamot and oil of peppermint, as likewise the bodies menthol, carvol, and myristicol, have an unknown constitution. The three latter substances are known to be isomeric (*Journ. Chem. Soc.*, vol. xxv., p. 1).

Great interest is attached to our examination of these bodies, since we consider it to be proved from the character of the spectra they transmit that the nucleus of menthol is a terpene, while the benzene ring is the inner basis of carvol and myristicol. Bergamot appears to be a terpene mixed with some derivative of the aromatic series; but the oil of peppermint, on the other hand, is essentially a substance belonging to this latter class. The refraction equivalents of carvol and myristicol are abnormal, like those of benzene derivatives, a fact which confirms our conclusions regarding the constitution of those substances.

The following is a summary of our observations with regard to the terpenes:—

1. The terpenes with the composition $C_{10}H_{16}$ possess, in a high degree, the power of absorbing the ultra-violet rays of the spectrum, though they are inferior in this respect to benzene and its derivatives, to which class of bodies they are so closely allied.
2. Terpenes with the composition $C_{15}H_{24}$ have a greatly increased absorptive power for the more refrangible rays,—that is to say, they withstand dilution to a greater extent the greater the number of carbon atoms in the molecule.
3. Neither the terpenes themselves nor the oxidised or hydrated derivatives occasion absorption-bands under any circumstances when pure, but always transmit continuous spectra.
4. Isomeric terpenes transmit spectra which generally differ from one another in length, or show variations on dilution.
5. The process of diluting with alcohol enables the presence of bodies of the aromatic series to be detected in essential oils, and even in some cases the amount of these substances present may be estimated.

Several diagrams in illustration of the kind of absorption exerted by the different substances are presented with the complete Paper.

ON THE USE OF THE POLARISCOPE IN DETERMINING THE PROGRESS AND COMPLETION OF OXIDATION IN CONVERTING ANTHRACENE, CRUDE OR OTHERWISE, INTO ANTHRAQUINONE.

By BENJ. NICKELS, F.C.S., F.I.C.

It is well known that the crystalline form assumed by anthracene and its oxidised product anthraquinone differ widely, the former as deposited from a tolerably strong benzol solution, in sharp tabular overlaying plates; anthraquinone, on the other hand, in distinct needle and stellated groups.

Examined polariscopically, both compounds present very beautiful objects, the former as crystallised in the tabular form exhibiting a superb play of colours; while from a weaker solution, small, but on characteristic leaflets of an intense cobalt blue tint, anthraquinone similarly viewed presenting coloured bands only, crossing the needles individually or grouped.

Other substances accompanying crude anthracene, such as carbazol, acridine, phenanthrene, pyrene, chrysene, also exhibit to an extent distinctive and characteristic forms, but as compared with anthracene, whether as hydrocarbons or oxidised products, so entirely opposite that limited observation readily distinguishes them. Naphthalene is the only body in any way resembling anthracene, but here again with equally characteristic difference, and to a careful observer there need be no error in judgment.

As will readily be seen, mixtures of these substances should be distinguishable with the same facility as the starches, and to an extent this assertion is borne out, but not without some care and experience in the preparation of the sample to be examined. It is, however, in admixture with oxidised, or partially oxidised anthracene, that the mode of observation indicated becomes of value, and a very ready method of following the process of oxidation as it proceeds. This operation, thanks to the researches and elaborate publications of Perkin, Caro, Graebe, Liebermann, and others, is now so well known that little need be said concerning it. Briefly, however, partially purified anthracene is subjected to the action of boiling potassium bichromate and diluted sulphuric acid. When employed in carefully adjusted quantity the anthracene only is attacked, and the associated or unoxidised bodies afterwards removed by further processes also equally well understood.

The operation is one of some nicety, inasmuch as too little "bichrome" involves actual loss of anthracene, and too much, complicating after process in purifying the resulting anthaquinone.

In view of the necessity of this close adjustment in the use of oxidising agents, it has been suggested to make laboratory trials on each and every sample of crude material before passing it into the works. Without in any way denying or calling in question the value of this mode of examination, I would venture to think the operation may be more easily controlled during the factory process of oxidising, and by withdrawing from time to time, as the operation proceeds, about one gramme of the partially converted anthracene from the oxidiser, washing, drying, dissolving in boiling benzol, and depositing one drop of the filtered solution on a glass slide for microscopic and polariscopic examination.

A detailed description of the varying appearance, as the operation proceeds, would involve much writing, but sufficient to say it is so well marked and defined that any observer accustomed to microscopy will readily discern features not to be disregarded in proportion as the oxidation proceeds; the needles of anthraquinone become more and more defined, increasing in quantity until finally, in a well-conducted operation, they occupy the entire field of view, traces of anthracene crystallise out quite independently, and creeping towards the outer edge of the circle are at once recognised by an experienced observer. Larger proportions stud the field in the characteristic and easily traced blue leaflets. 5 per cent of anthracene left unoxidised in the finished product for "crude," and as incated by appropriate and well-known tests is sharply and unmistakeably discriminated as anthracene, even in the presence of associated bodies, and in the course of a few minutes only, thereby enabling the manufacturer to add further quantities of oxidising material up to the exact point of final conversion of available anthracene.

I need scarcely say that some experience is necessary with this test, simple as it may appear. I shall have much pleasure in exhibiting its details, as occasion permits, to those sufficiently interested on calling at my laboratory.

Leadenhall Street E.C. Nov 25, 1879.

NOTES OF SOME OBSERVATIONS ON NITRIFICATION.[*]

By EDMUND W. DAVY, A.M., M.D.,
Professor of Forensic Medicine, Royal College of Surgeons, Ireland, &c.

A good deal of attention, on the part of chemists, has of late been given to the subject of nitrification, or the formation of nitrites and nitrates under different circumstances. This has arisen, in a great measure, from the observations of MM. Schlœsing and Müntz,[†] which were laid before the Academy of France about two years ago. From the researches of those gentlemen, they arrived at the conclusion that nitrification was due to an organised ferment, and that it was probably the office of some of the low forms of vegetable life to produce those oxides of nitrogen under different circumstances. And the subsequent investigations of Warington, Storer, and of other chemists, would appear to go far to confirm the correctness of their theory of nitrification, at least under the conditions in which their experiments were made. Though there exists, no doubt in many cases, an intimate relation between the formation of nitrites and nitrates, and the development of certain organised germs, still as far as my observations go, I do not think that there is sufficient proof to show that their development in such instances is the cause of nitrification, and not, rather, one of the circumstances attendant on that process.

My experiments, however, were made not with a view to determine that question, but in reference to the detection of animal impurities in potable waters, and to ascertain the circumstances which were favourable or otherwise to the formation of nitrites and nitrates in waters which were so polluted, as the presence of such salts is generally regarded as indicating previous sewage contamination, and the drinking of water with such pollution is not only injurious to the health of those who thus employ it, but there exist strong grounds for the opinion which is now very generally entertained, that such water frequently becomes the means of conveying the germs of certain formidable diseases, especially those of typhoid fever and cholera, from its containing the fæcal and other emanations of individuals labouring under those maladies, and thus disease and death are often insidiously brought into many homes when such diseases are prevalent in different localities.

Besides, as the formation or production of nitrates is one of great industrial and agricultural importance, any facts which might directly or indirectly enable us to facilitate or hasten that process would be of much practical value.

As human urine and feculent matters may justly be regarded as the most offensive and dangerous ingredients of sewage in general, my experiments have been confined to those matters, and were principally made on urine, which, from its containing different nitrogenous substances, readily susceptible of decomposition, is peculiarly suited for the study of the nitrification of animal matters. By mixing this liquid with various proportions of water, and placing the mixtures under different circumstances, I have endeavoured to ascertain those that were favourable or otherwise to their nitrification; and to determine some points connected with that process which required further investigation. I should here observe that in detecting the occurrence of nitrification I have principally used the well-known test of Price for nitrites, which consists in adding to the water or mixture a thin solution of starch, containing a little iodide of potassium, and acidifying with diluted sulphuric acid, when a blue reaction from the liberated iodine will be immediately produced, should a very minute quantity of a nitrite be present. And as there is every reason to suppose that the production of nitrites precedes that of nitrates in the nitrification of organic matters in solution, and the detection of the former is much more easily effected than the latter, at least under the conditions existing in my experiments, I was satisfied in most cases to obtain the evidence of the formation of nitrites by the employment of the test to which I have just referred.

The experiments of Warington[*] have led him to conclude that darkness is an essential condition to the development of those low forms of vegetable life which are supposed in many instances to give rise to nitrification.

This is a question which it is difficult to determine decisively one way or the other, owing to the impossibility of having with us continuous daylight to operate with. Still I think we may arrive at an approximative conclusion on this point, by making comparative experiments on similar mixtures, kept altogether excluded from the light, and on those exposed to its full influence, and then determining the amount of nitrification which had taken place in each, after a given time; and if darkness be so essential to that process, we should naturally expect that in the mixtures exposed to its continuous influence there would be an earlier and a greater development of nitrification, than in those which had been placed under it for about one-third or one-half the time, each day of twenty-four hours.

From the results of several comparative experiments made in this way, I have come to the conclusion that the conditions of light or darkness exercise but little influence one way or the other in this process, at least under the circumstances existing in my experiments, which consisted in placing different portions of the same mixtures in similar bottles, some of which were surrounded with black cloth or velvet to exclude light, whilst others were left uncovered, and all of them were suffered to remain open or uncorked. On examination after a few days there was but little difference as to the amount[†] of nitrification that had taken place in each—indeed in some of my experiments it had progressed to a greater extent in the uncovered than in the covered bottles; and in all made on this subject (except those to determine this point as to the necessity or not of darkness), the mixtures were left exposed to the light, and some to the full influence of strong sunshine, yet still a considerable amount of nitrification took place in each. Besides, in nature much of the nitrates which occur in the surface soils of different localities must have been formed under the influence of more or less daylight; all of which facts, I conceive, are more or less opposed to the necessity of darkness in this process.

Another point which has not, I believe, been clearly established, at least as regards nitrification occurring in water containing organic matters, is the necessity of having a certain amount of air or free oxygen to carry on the process; this I have proved in the following very simple manner:—To water which had been kept boiling for some time to expel its contained air, I added a small quantity of freshly voided urine (the proportion employed being about one part of urine to sixteen parts of water, such a mixture having been proved to be very suitable for nitrification), and then repeated the boiling to ensure the removal, as far as possible, of any dissolved air. Several bottles which had been kept immersed in the boiling mixture were then filled completely with it, corked, and sealed with sealing-wax, to prevent the access of air. Some, however, of them containing this mixture were left open for comparison. After leaving the bottles for a day or two in the same place, I first examined the open ones for nitrites, and when the test indicated the abundant formation of those

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[*] Read before the Royal Irish Academy, May 12, 1879.

[†] *Comptes Rendus*, lxxxiv., 301.

[*] *Journal of the Chemical Society*, January, 1878.

[†] In ascertaining the amount of nitrification, the indigo process as described by Sutton in his "Volumetric Analysis" was employed which served for the determination of the nitrites and nitrates collectively: and though it may not be quite so accurate as some other methods, was sufficiently so for this purpose, as it was only the comparative amounts of nitrites and nitrates formed under the different circumstances of the experiments that I wanted to determine.

salts, I opened one of those sealed, when not a trace of nitrites was discoverable in its contents; the remaining sealed ones were opened at different periods subsequently, with the same results. Other comparative experiments were made, where the temperature of the mixtures was artificially kept at a heat very favourable to nitrification, but, in every instance where the access of air had been excluded, no trace of nitrites could be detected—clearly proving the necessity of more or less air or free oxygen for their formation. But the amount necessary to commence, at least, the process, is small, for I found where the mixture had not been boiled previouly to the complete filling, corking, and sealing of the bottles, that the air dissolved in the liquid was sufficient to cause the production of nitrites to some extent.

The quantity of animal matter which is held in solution in the water, I find exercises a considerable influence over nitrification; for where it occurs in very large proportion, there the process either does not take place at all, or is carried on much slower than in the more dilute solutions. This I have proved by comparative experiments with water mixed with different proportions of the same sample of urine, or of solution of excrementitious matter, where I found that nitrification occurred first in the more dilute mixtures; and that where there was much organic matter present, that the nitrites which might ultimately be formed soon afterwards disappeared again by their subsequent change or decomposition, whereas those that had been produced in more dilute solutions have remained unchanged for a considerable time.

But the circumstance which I have found to exercise the greatest influence over nitrification is that of temperature; for I have observed that in cold weather it is very slow in taking place, whilst in warm it is much quicker, and that by the application of artificial heat the process can be greatly accelerated. The correctness of this observation is borne out by the well-known fact, that it is from the soils of different hot climates that we obtain our chief supply of nitrates.

As to what may be the most favourable temperature for this process, I have not yet been able to determine, owing to the difficulty, as I am circumstanced, in maintaining continuously the same degree of artificial heat; but I have found that where the mixtures were placed where they were kept at a temperature which varied from about 70° to 80° F., that there the process was carried on very quickly, and that nitrites were soon abundantly formed, whereas similar mixtures maintained at lower degrees of heat, or at the ordinary temperature, not a trace of those salts could be detected in the same time, and that their presence was not discoverable till after a much longer period.

The foregoing observations have, I conceive, some important bearings as regards the contamination of water with sewage, and the evidence of such, derivable from the occurrence in it of nitrites and nitrates. For though the presence of those salts is undoubtedly in many instances an indication of previous sewage pollution, still their absence, taken by itself, cannot be relied on as a sure indication of the freedom of the water from such contamination. For the circumstances present may have either been unfavourable to the formation of nitrites and nitrates, or have produced their subsequent rapid disappearance—thus, for instance, the lowness of the temperature of the water may have prevented their formation, or the quantity of organic matter present may have interfered with their development, or have led to their subsequent change and disappearance. Such, amongst other circumstances influencing the presence of those salts in water containing animal matters, will at once be evident; and their absence unless accompanied by other indications of purity, cannot be relied on as a proof of the freedom from such contamination.

Before I conclude, I wish to call attention to another fact, which I have noticed in connection with this subject, *viz.*, the rapidity with which nitrites are sometimes formed in waters contaminated with sewage impurities. This is a subject of considerable importance in an analytical point of view, as I shall endeavour briefly to explain.

It is well known by those who have analysed potable waters, that the method which chemists now principally employ to ascertain their purity or otherwise is to determine the quantity of ammonia a given amount of the water will yield on distillation, both before and after the addition of a strongly alkaline solution of permanganate of potash. The first obtained is termed the free and the second the albuminoid ammonia. The former is regarded as the representative of the nitrogenous organic matters previously existing in the water, which have undergone more or less decomposition, whilst the latter is produced by the action of the alkaline permanganate on those substances still present in the water. Consequently, the less of each that is furnished by a sample of water when so treated, the purer organically is it regarded, and the safer, other circumstances being similar, would it be for potable purposes. When lately analysing a sample of water that had been contaminated with sewage, to ascertain the amount of such pollution, which was afterwards the subject of an important legal inquiry, in my first trial I found that the water yielded a quantity of free ammonia which was equivalent to 0·970 part of a grain per gallon, but on repeating the determination a few days afterwards, it was discovered that it had fallen to 0·186 part of a grain for the same quantity of water, or to less than one-fifth of the former amount; whereas the quantity of albuminoid ammonia yielded had slightly increased. This result as to the great decrease of free ammonia, which at first rather surprised me, I ascertained was due to the formation of nitrites, which had been developed to a large extent, in so short a time, at the expense of the free ammonia. Such being the case, if the water had not been examined till the date of the second analysis, and if the nitrites had not been taken into account, this water would have been regarded as containing much less free ammonia than it did, and consequently that the previous sewage contamination was less than it really was; this point is therefore one of some analytical importance.

It is right for me to observe, in connection with this latter fact, of the decrease of free ammonia in waters by keeping, that long after I had made that observation I met with (in the CHEMICAL NEWS, vol. xxxv., p. 94), a letter written by Professor Pattison Muir, of Owen's College, in which he calls the attention of chemists to some observations his brother had just made in the laboratory of the University at Sydney, in which he had noticed that the amount of free and of albuminoid ammonia, as determined by Wanklyn's process, varied very considerably with the time the sample of water had been kept; but neither of those gentlemen has offered (in the letter referred to) any explanation of the fact, further than that Prof. P. Muir throws out the suggestion, in the case of the increase by keeping of the albuminoid ammonia, that possibly it might have been owing to the germs which have escaped decomposition by the permanganate undergoing a gradual decomposition in the water, and that ammonia is one of the products of this process. Be this as it may, I have satisfied myself that the loss of free ammonia is often due to the formation of nitrites or nitrates, which are very rapidly formed under different circumstances. And as regards albuminoid ammonia, the very slight increase which I observed in my experiment was, I thought, very easily accounted for by my having in the second determination carried on the process of distillation somewhat further than in the first trial, and in this way the amount might be very naturally increased.

Finally, my observations that nitrification is greatly promoted by warmth might, I conceive, admit of some practical application in the manufacture of the nitrate of potash in the artificial nitre beds, especially in those of cold countries; and I am not aware that heat has hitherto been anywhere artificially applied to hasten or promote that important manufacture.

ON THE SEPARATION OF THE HEAVY METALS OF THE AMMONIUM SULPHIDE GROUP.

By CLEMENS ZIMMERMANN.

After pointing out that the usual procedures are either very tedious or questionable as to accuracy, the author gives his method for separating zinc from the other metals of the group by means of ammonium sulphocyanide. To the liquid in question, which, in addition to the zinc salt, may contain any number of the other metals of the fourth group, iron and uranium, if present, being in the state of ferric and uranic salts, he adds, if its reaction is acid, carbonate of soda till a slight turbidity appears, neutrality being the main condition for success. An excess of a solution of ammonium sulphocyanide, not too dilute, is then added, the sides of the vessel are rinsed with water at 60° to 70°, preferably by means of an Erlenmeyer flask, and a very moderate stream of sulphuretted hydrogen is introduced repeatedly, but not very long, till the odour of this gas does not disappear after the liquid has stood for some time. During the introduction of the gas the appearance of a milky-white precipitate is first perceived, and after a considerable time zinc sulphide is separated in flocks which continually become denser. The beaker is now exposed to a gentle heat till the precipitate has settled and the liquid has become clear, which may require six hours. It is then filtered, the white zinc sulphide is washed with water containing sulphuretted hydrogen and ammonium sulphocyanide, and dried. This precipitate contains all the zinc, free from the other heavy metals of the group. When dry it may be ignited in a current of hydrogen according to Rose's process (*Poggendorff*, cx., 128), or it may be dissolved in hydrochloric acid, evaporated to dryness in a weighed platinum capsule on the water-bath, mixed with an excess of elutriated mercuric oxide, pure, and free from alkali, evaporated to dryness, and ignited. Zinc oxide remains perfectly pure and without loss, and is weighed when cold.

In the filtrate from the zinc sulphide the sulphocyanides are first destroyed by means of nitric acid, which at the same time peroxidises any ferrous or uranous salts present. This operation is best effected in a roomy long-necked flask, which is heated on the water-bath, and nitric acid added by degrees in small portions until the liquid no longer becomes red, followed by decolouration. Any yellow cyanogen persulphide formed is filtered off. If the acid is added too rapidly the liquid may be projected out of the flask.

In order to separate the iron present from nickel and cobalt, the solution, which may contain ferric salts along with nickelous or cobaltous salts or both, is mixed with an excess of ammonium sulphocyanide, when the blood-red colour of iron sulphocyanide appears; a solution of "secondary" carbonate of soda is then added drop by drop, till the red colour just disappears. All the iron is thus precipitated as ferric hydroxide, none of it remaining in solution, and no cobalt or nickel being thrown down. The precipitate is allowed to settle, filtered, washed with boiling water to which a little ammonium sulphocyanide has been added, dried, ignited, and weighed. The filtrate is treated as has been directed for the filtrate from zinc sulphide. The author separates cobalt and nickel by Liebig's method with ferric oxide.

For the separation of iron and uranium the liquid, in which the metals must have been peroxidised, is brought to a boil, mixed with an excess of ammonium sulphocyanide, and aqueous carbonate of soda is added, exactly as above directed for the separation of iron from cobalt and nickel. The same process is further followed for the removal of the iron, which is found free from the slightest trace of uranic compounds.

The filtrate which contains uranic oxide in solution is first treated with nitric acid to destroy the sulphocyanogen, then neutralised with ammonia, and mixed with ammonium sulphocyanide; the precipitate of uranium oxy-sulphide is boiled, by which it is resolved into sulphur and uranous oxide, filtered, dried, and ignited. Lastly, the uranium is either weighed as uranoso-uranic oxide, or converted into uranous oxide by very strong ignition in a current of hydrogen gas which is maintained until the product is cool.

The precipitation of uranic oxide by ammonia is greatly promoted by the addition of ammonium chloride, without which it does not take place in dilute solutions.—*Annalen der Chemie*, 199, 1.

INFLUENCE OF ACETIC ACID ON THE SEPARATION OF IRON AS A BASIC ACETATE FROM MANGANESE, ZINC, COBALT, AND NICKEL.

By JOHN JEWETT.

It has often been observed, when manganese is separated from iron by precipitating the latter as a basic ferric acetate, that some manganese is carried down with the iron precipitate. Eggertz,* calling attention to this fact, stated that this trouble could be obviated, at least to a great extent, by the presence of free acid. To this end he recommends adding to a volume of 500 c.c., after nearly neutralising with sodium carbonate, 3 c.c. of HCl (strength not given). Stœckmann communicated in *Fresenius's Zeit.* (1877, p. 172) the results of a series of experiments in separating iron from manganese in "spiegeleisen" containing about 10 per cent of manganese. He found that varying, and usually very considerable, amounts of manganese were precipitated along with the iron, in many cases equalling 10 per cent of all that was present, and concludes that it is absolutely necessary to re-dissolve and re-precipitate the iron and recover the manganese in the second filtrate. He alluded to the modification recommended by Eggertz, but did not adopt it, finding the free acid made the iron precipitate difficult to wash. C. Kræmer† was astonished at these results, and states that the only precaution necessary (besides thorough washing) is the addition of one or two drops of dilute acetic acid to the previously neutralised solution, before adding sodium acetate and boiling; he found that at most only one-tenth per cent of manganese goes down with the iron. The experience of G. Matzurke‡ was, on the other hand, quite like that of Stœckmann. He found, contrary to Kræmer, that the addition of one or two drops of dilute acetic acid made no appreciable difference in the results.

In view of these statements concerning a much-used process, I have, with the advice of Prof. O. D. Allen, made some experiments to ascertain the influence of free acetic acid in this method of separating iron from manganese and the other metals, zinc, cobalt, and nickel. As a basis of operation, solutions of Fe_2Cl_6 containing free HCl, and of $MnCl_2$, $ZnCl_2$, $Co(NO_3)_2$, and $Ni(NO_3)$, of known strength (0·2 gr. of the metals to every 100 c.c. of solution), were made; then by uniting 100 c.c. of the iron solution with the same amount of any one of the other solutions, a mixture of the desired metals to be separated was obtained. A few preliminary trials with iron and manganese gave results in accordance with the statements of both Stœckmann and Eggertz. Presence of free acid decreased the amount of manganese in the iron precipitate, but *too much* prevented complete precipitation of the iron. To ascertain to what extent free acetic acid is efficient in keeping manganese—likewise zinc, nickel, and cobalt—in solution, when present in quantities not too great to prevent precipitation and washing of the iron, necessitated a series of experiments, in which the only variable factor was the acetic acid. In every case 2 grs. sodium acetate were used (an amount equal to ten times the weight of iron

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* Berg- und Huettenmænnische Zeitung, 1867, p. 187.

† *Fresenius's Zeitschrift*, 1877, p. 334.

‡ *Ibid.*, 1878, p. 78.

present), and the solutions were diluted to the same volume, viz., 300 c.c. before boiling to separate iron. The precipitated iron was examined after thorough washing, by re-dissolving and repeating the separation, and testing the filtrate from the iron precipitate, according to whether Mn, Zn, Co, or Ni was present, with Br, $NaCO_3$, or NaOH. The results are here tabulated :—

Per cent by volume of Acetic Acid (1044 sp. gr. added).	Taken Fe=0·2 gr. Mn=0·2 „ P. ct. of Mn in 2nd Filtrate.	Taken Fe=0 2 gr. Zn=0 2 „ P.c of Zn in 2nd Filtrate.	Taken Fe=0·2 gr. Ni=0·2 „ P. c. of Ni in 2nd Filtrate.	Taken Fe=0·2 gr. Co=0·2 „ P.c. of Co in 2nd Filtrate.
0	2·788	—	—	—
⅛	0·697	2·849	1·888	—
1	0·585	2·046	1·770	0·590
2	0·193	—	1·652	—
3	0·154	—	1·468	—
4	trace	0	1·219	0·315
4	trace	0	—	—
5	trace	—	0·314	—

It was found that 4 per cent by volume of acetic acid, 1·044* sp. gr., has no appreciable bad effect on the separation and filtration of the iron ; when 5 per cent is used its effect is sometimes apparent, but occasions no great trouble. On making some trials with over 5 per cent, iron was not always completely precipitated, and was very difficult to wash. Great care was taken in these experiments to have as little free acid as possible present besides that intentionally added. This end can best be attained by adding sodium carbonate to the *cold* and preferably concentrated acid solution until a slight precipitate forms, which no longer re-dissolves by shaking and allowing to stand three or four minutes, but imparts a turbidity to the deep red solution ; HCl must then be added without longer delay, drop by drop, until the fluid, though still dark, becomes clear. After neutralising in this manner, the amount of acetic acid required to form the desired percentage of the final volume was added, next sodium acetate, and lastly the solution was diluted to the final volume (viz., 300 c.c.) before boiling. Long boiling of the precipitate was avoided, one or two minutes sufficing to make the basic acetate settle quickly after removing the heat. The precipitate was washed with nearly boiling water, to which 2 grs. sodium and 1 c.c. acetic acid, per litre, had been added, until $AgNO_3$ gave no reaction with the washings.

It may be concluded, from the results shown in the table, that by using 4 per cent by volume of acetic acid, 1·044 sp. gr., and adhering to the above precautions, a complete separation by one precipitation can be obtained of zinc, and one sufficiently accurate for most purposes of manganese ; while the amount of nickel and cobalt that goes down with the iron lessens with increase of acetic acid. The following quantitative separations of iron from zinc and manganese were also made. Precipitation was effected in a volume of 300 c.c. containing 12 c.c. acetic acid, *i.e.*, 4 per cent of this volume and 2 grs. sodium acetate.

Fe taken. Grs.	Zn taken. Grs.	Mn taken. Grs.	Fe found. Grs.	Zn found. Grs.	Mn found. Grs.
0·1966	0·1997	—	0·1995	0·1994	—
0·2000	0·2000	—	0·1998	0·1999	—
0·1996	—	0·2000	0·1983	—	0·2002
0·2000	—	0·2000	0·1993	—	0·2001

Other Variable Conditions.

A volume less in proportion to the iron present may doubtless be advantageous when large quantities of iron are to be precipitated. The writer, however, would not recommend, on account of increased difficulty of washing, less than 100 c.c. per 0·1 gr. Fe.

Experiments made by E. H. Smith in this laboratory, on the separation of iron from manganese, under exactly the same conditions as described, except that double the amount of sodium acetate was used, gave essentially the same results.

He further ascertained that iron could not be precipitated in presence of a larger amount of acetic acid by increasing the amount of sodium acetate.

Since solutions containing free acid may be neutralised with ammonia or ammonium carbonate instead of sodium carbonate, when the presence of ammonium salts is not objectionable,—for example, in separating nickel from iron,—I have duplicated some of the above experiments with nickel, with no other change than the addition of ammonium chloride. The results are appended, showing the difference when NH_4Cl is present :—

Per cent by volume of Acetic Acid (1·044 sp. gr. added).	Per cent of Ni in 2nd Filtrate.	Per cent of Ni in 2nd Filtrate, when 5 grs. NH_4Cl were added.	Difference.
1	1·770	0·904	0·866
3	1·468	0·708	0·760
4	1·219	0·511	0·708

—*American Chemical Journal.*

NOTICES OF BOOKS.

Analytical Chemistry. By W. Dittmar. Pp. 88. London and Edinburgh : W. and R. Chambers, 1879.

It constantly happens that beginners in practical qualitative analysis are disheartened by the mass, the variety, and the complexity of the directions given in the ordinary manuals. What with alternative processes, cross-references, cautions, foot notes, appendices, and the introduction of the rarer metals, the beginner is hopelessly puzzled, and abandons all attempt to learn the method of analysis in a thorough and systematic manner. For beginners and for those students who have no occasion to carry their analytical course very far, we can heartily recommend Professor Dittmar's compact, clear, and practical little book ; and, as an introduction to larger and more complete works (like the "Qualitative Analysis" of Fresenius), it will prove useful, since, so far as it goes, its statements are accurate and its methods practicable. There is no attempt to shirk the real difficulties of analytical operations and explanations ; only a wise judgment has been exercised in selecting what shall be given and what shall be withheld.

This book consists essentially of a series of laboratory exercises, beginning with dry-way tests, then come wet-way reactions, and then the application of the facts observed to what Prof. Dittmar calls "the A B C of metal analysis." Next we have schemes for the examination of solutions for metals and for inorganic acids, and finally some instructions as to the characteristic reactions of organic acids. An appendix, intended for medical students, relates to the alkaloids, sugars, starch, and urine.

The pages before us are not only remarkably free from errors but contain a large number of valuable hints and precautions, not usually to be found in small treatises of an elementary sort. We fail to discover any but quite insignificant corrigenda.

A Treatise on Chemistry. By Professors Roscoe and Schorlemmer. Vol. II., *Metals*, Part II. London : Macmillan, 1879.

This volume fulfils and more than fulfils the promise of its two predecessors. It treats with adequate fulness and freshness of the metals of the iron, chromium, tin, antimony, and gold groups. Special attention has been paid by the authors to technical processes both in the way of verbal description and engraved illustrations. The metallurgy of iron and the manufacture of glass are justly cited

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* This acetic acid, by volumetric determination, was found to conain 33·16 per cent $C_2H_4O_2$.

in the preface as examples of the pains that have been devoted to the due illustration of important operations, plant, and apparatus connected with chemical and metallurgical manufactures. The last part of the volume before us is occupied with three supplementary chapters of considerable scientific importance. The first of these treats of spectrum analysis, especially so far as terrestrial matter is concerned; the second discusses the natural arrangement of the elements and the periodic law of Mendeleeff, while the third is occupied with a description of the methods and apparatus by which Pictet and Cailletet liquefied the so-called permanent gases—hydrogen, oxygen, carbon monoxide, &c. We may say at once that these three supplementary chapters leave nothing to be desired, either as to completeness, accuracy, or fairness, while the illustrations which accompany them are of equal excellence with those which adorn the previous portions of the work under notice.

Nearly two dozen metallic elements with their more important compounds are described in the less than 500 pages of the present volume. But the authors have rightly assigned appropriately larger spaces to the accounts given of such important metals as iron and gold, while the rarer and obscurer metals are more briefly, yet quite sufficiently, described. Naturally, however, vanadium, on which Prof. Roscoe has so successfully laboured, comes in for a much more complete discussion than some of the other metals which must be regarded as scarce. We confess we should like to see a few of the important constants of each metal prefixed or suffixed to the descriptive accounts given, so as to offer to the reader in a compact tabular form for immediate reference and comparison the best and latest results of chemical and physical investigations. Another suggestion we venture to make has reference to the mineralogical references in the volume before us. We cannot but commend the introduction of some account of the minerals which form the raw material of all researches into metals and their compounds; but we cannot understand the peculiar spelling and nomenclature adopted for many of the species here introduced, nor can we explain the exclusion of some of the most interesting kinds: then, too, in some instances, quite inadmissible formulæ are assigned. We give a few instances of these three peculiarities, which, considering the remarkable pains bestowed upon almost all the departments of chemical knowledge covered by this treatise, are the more unaccountable.

We begin by asking why rhodochrosite should be changed to rhodocrozite (p. 2); erythrite to erythine (p. 132); and uranocalcite to uranochalcite (p. 225)? The latter change is most unfortunate, implying, as it does, the presence of copper instead of lime in the mineral, although the formula given is that of an uranyl—calcium phosphate: by the bye, this species contains $10H_2O$, not $8H_2O$. Stiblithe for the mineral called stibiconise by Beudant, and stibiconite by Brush and Dana, is a form which does not commend itself on the score of euphony; nor is the memory of the Comte de Bournon honoured by changing bournonite into bournanite. It is a pity that a number of such small inaccuracies in names and formulæ should have crept into a work so carefully prepared as this valuable standard treatise on chemistry. We do not refer to mere misprints, like musirum, on p. 251, nor hæmogoblin (so curiously associated with spectra), on p. 495; such accidents will happen to the most expert and painful readers of proof.

Remarkable Behaviour of Silver Oxide.—Prof. Böttger.—If two measured parts of silver oxide, perfectly dry, are rubbed in a porcelain mortar with 1 part antimony sulphide the mixture readily takes fire. The same phenomenon occurs if silver oxide is ground along with amorphous phosphorus. If a drop of phenol is thrown upon silver oxide the latter is partially reduced, with the projection of sparks.—*Polyt. Notizblatt*, xxxiv., 322.

CORRESPONDENCE.

OZONISERS.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xl., p. 246, is described, by Mr. Albert R. Leeds, various forms of ozonisers. He does not mention mine; and it is possible he may not have heard of it, notwithstanding that it was shown at a soirée of the Royal Society some thirteen or fourteen years since.

It was, as you are aware, composed of sheets of glass, coated with tin-foil, with longitudinal slips of glass, uncoated, placed along each side, thereby forming cells, and the whole placed in a wooden box coated with shellac varnish. When large quantities of ozone are required the cells can be built up to any height, so that a very large area is obtainable. The construction is exceedingly simple.

With this ozoniser I found the best result by exposing a small surface of foil—a strip about 1 inch wide—across the plates, highly charged. With a large surface of foil and the same battery power, a very small result was obtained.—I am, &c.,

Edwd. Beanes.

Moatlands, Paddock Wood, Brenchley, Kent,
November 25, 1879.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 20, November 17, 1879.

Temperature of the Decomposition of Vapours.—H. Sainte-Claire Deville.—The author remarks that the experiment of M. Troost (*Annales de Chimie et Physique*, Série v., Tome 12) on the hydrate of chloral and on its existence in the state of vapour, is one of those which may be called crucial, and has stung to the quick all the partisans of the atomistic chemistry. The procedures and the apparatus used by M. Wurtz in his researches on chloral hydrate are the same as those described by the author more than fifteen years ago. M. Berthelot has perceived that M. Deville has avoided the causes of error which attach to this apparatus as reproduced by M. Wurtz. A rise of temperature is an incontestable sign of the combination of two gases, but this does not hold good for vapours, especially for those which M. Wurtz has employed, those of chloral and of water at temperatures near their point of condensation.

Observations on a Note by M. D. Cochin relating to Alcoholic Fermentation.—M. Berthelot.—The author presented the views ascribed to him by M. Cochin, not as absolute opinions, but merely to explain the leading idea of the experiments of Claude Bernard. To refer a chemical metamorphosis to a vital act is not to explain it. On the contrary, all the efforts of physiological chemistry have for their object to analyse the material changes which take place in living beings, and refer them to a regular succession of chemical acts.

Observations on the Ultra-violet Limit of the Solar Spectrum at Different Altitudes.—A. Cornu.—The extension of the limit of the spectrum estimated in wave-lengths ought to be a millionth of a millimetre for every 663 metres of altitude. The rate of progression is conformable to the theoretic value deduced from the hypothesis of a homogeneous absorbent atmosphere, but on condition of choosing as numerical data those corresponding to days when the atmosphere is purest. The actual extension of the spectrum in the ultra-violet direction is one unity (millionth of a millimetre) for every 900 metres of height.

Explosion of Carbonic Acid in a Coal Mine.—M. Delesse.—The explosion occurred in the coal mine of Rochebelle (Gard). The following reasons are given to show that it was not occasioned by carburetted hydrogen:—The detonations were not accompanied by flame; the bodies and clothing of the victims bore no marks of burning, and powder and cartridges in the mine had not been ignited; fire-damp has never been observed in the mine, but an escape of carbonic acid has often been observed and has been combatted by ventillation. The explosion would seem to have been merely the sudden liberation of an enormous volume of this gas.

Second Note on the Effects and Modus Operandi of Antiseptics: Their Action upon Pus.—MM. Gosselin and A. Bergeron.—Pus putrefies more slowly than blood; its putrefaction is retarded by incomplete occlusion. It is retarded by antiseptics, both in actual contact and at a distance. Camphoretted spirit, phenol at 1-50th, and alcohol at 86° are equally moderators of inflammation and preservatives against septicæmia.

Critical Reflections on Experiments Concerning Human Heat.—G. A. Hirn.—Not susceptible of abstraction.

Atmospheric Polarisation and the Influence which Terrestrial Magnetism may exert upon the Atmosphere.—Henri Becquerel.—The author infers from his researches the existence of a variable divergence between the plane of the sun and the plane of the polarisation of the atmosphere in any point whatever, and the manifestation of a magnetic influence of the earth upon the atmosphere.

Solar Spots and Protuberances Observed with a Spectroscope of Great Dispersive Power.—L. Thollon.—This paper requires the accompanying illustrations.

On Chlorophyll.—A. Gautier.—The author has obtained chlorophyll in crystals belonging to the system of the oblique rhomboidal prism. On exposure to diffused light they turn slowly to a yellowish green, and ultimately become colourless. In its reactions and its elementary composition it shows an approximation to bilirubine. Both are soluble in ether, chloroform, petroleum, sulphide of carbon, and benzol. Both are withdrawn from the majority of these solvents by animal black. Like bilirubin, chlorophyll plays the part of a feeble acid, yielding soluble and unstable salts with the alkalies, and insoluble salts with all the other bases. It contains not a trace of iron. Its relations with bilirubin connect it necessarily with hæmatin.

Les Mondes, Revue Hebdomadaire des Sciences.

No. 10, 1879.

Unpublished Letter from C. F. Gauss to Sophia Germain.—An astronomical paper.

State of Alkaline Phosphates in Solutions.—J. van Bemmelen.

A New Salt with an Iridium Base.—K. Birnbaum.

State of Double Salts in Solutions.—P. H. B. Ingenhoes.

Condensation-products of the Tertiary Aromatic Bases.—O. Fischer.—These four papers are all taken from the *Berichte der Deutschen Chemischen Gesellschaft.*

Vibratory Forms of the Bubbles of Glyceric Liquid.—C. Decharme.—Already noticed.

No. 11, November 13, 1879.

It is said that a M. Dalmas has succeeded in destroying the phylloxera by an electric process. The stems of the vines are wrapped round with thin copper wire, through which is passed the current of a powerful battery. Both the mature insects and their eggs are completely disorganised. No details are given.

The Metric System or the Battle of the French Standards.—C. Latimer.—The author pronounces the metric system "anti-scientific and anti-human."

The Superficial Viscos of Liquids.—J. Plateau.—Not adapted for abstraction.

Reversion of Superphosphates.—M. Joulie.—Taken from the *Annales der Chimie et de Physique.*

Bone-glass.—M. Sidot.—The author proposes to make glass simply of phosphate of lime, which he considers will prove very valuable. It is not attacked by hydrofluoric acid.

No 12, November 20, 1879.

Chemical Nomenclature.—M. Dulaurier.—In the author's system every element is to be represented by a consonant, whilst the number of molecules present in any compound is to be expressed by the vowels. Carbonic acid is xeka; ammonia, zodré, &c.

The article on the opposition between modern chemistry and the scholastic system is continued, as also M. J. Plateau's paper on the superficial viscosity of liquids.

Journal de Pharmacie et de Chimie.

November, 1879.

The Ferment of Carica Papaya.—A. Wurtz and E. Bochut.—Already noticed.

Action of Hypochlorite of Lime upon the Propylic, Butylic, and Amylic Alcohols.—J. Regnault and E. Hardy.—The authors investigate what are the chlorinised compounds resulting from the treatment of each of these three alcohols in an isolated state with the hypochlorite and hydrate of lime according to the method of Soubeiran. The resistance of the alcohols to the action of chlorine is the greater according as they belong to a more advanced term of the series.

Bark of Pala Mabi.—M. Planchon.—This paper is chiefly of a botanical pharmaceutical character.

Memoir on the Tritungstates.—Jules Lefort.—The tritungstates are not very stable, a character which distinguishes them, on the one hand, from the bitungstates, and, on the other, from the quadri- or meta-tungstates. The author has discovered the neutral tungstates, bi-, tri-, and quadri-tungstates of the sesqui-oxides.

The Elimination of Bromine from Bromo-citraconic Acid, and a New Organic Acid.—E. Bourgoin.—This acid differs from citraconic acid by possessing two equivalents less of hydrogen.

Oxidation of Formic and Oxalic Acids by Ammoniacal Oxide of Copper.—Paul Cazeneuve.—The product obtained is the ammoniacal carbonate of copper, similar to that obtained by Favre. The author is extending his researches to more complex acids.

Action of Digestive Ferments Employed in the Treatment of Dyspepsia.—M. Vulpian.—This paper is of a medical rather than of a chemical character.

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. October, 1879.

This issue contains the new German regulations concerning the transport of explosives. The substances included are gunpowder and blasting-powder; nitroglycerin and its preparations; nitrocellulose, especially gun-cotton; explosive mixtures containing chlorates and picrates; fulminating silver and mercury and their preparations. Explosives can be sold only to persons whose good reputation is known to the dealer, or who can produce satisfactory testimonials from the local authorities.

Chemiker Zeitung.

No. 43, 1879.

The Kurtz Process for the Manufacture of Nitroglycerin.—Not suitable for abstraction.

No. 45.

H. Hugershoff, of Leipzig, has introduced crucible-tongs with porcelain blades.

No. 46.

Preparation of Litmus as an Indicator.—M. Kretschmar.—Commercial litmus, ground very fine, is extracted with cold water till almost exhausted, and the extract is evaporated down with pure quartz-sand. During the evaporation hydrochloric acid is added till the liquid, after escape of the carbonic acid, appears strongly red. The brownish red dry powder thus obtained is ground up, and washed first with hot and then with cold water upon large smooth filters. The first washings are a dirty brown-red, and turbid. The water then passes through clear, and finally becomes a vinous red. The residue on the filter is perfectly dried on the water-bath. For use, a larger or smaller quantity is placed upon a filter, covered with hot water and a few drops of ammonia, and washed till the sand is exhausted. The filtrate is acidified with a few drops of very dilute sulphuric acid and then neutralised.

Alizarin Blue.—G. Auerbach.—The author gives analytical details in confirmation of a former paper.

Compounds obtained from Animal Tar.—Dr. H. Weidel and G. L. Ciamician.—Animal oil freed from bases contains as main products the nitriles of butyric, valerianic, capronic, capric, palmitic, and stearic acids, as well as pyrrol, homopyrrol, and dimethyl-pyrrol.

No. 47.

The Relation of the Litre to the Kilogramme.—For practical purposes the litre is defined as that space which is taken up by a kilo. of water weighed at 15° C., and at a mean barometric pressure of 760 m.m.

A New Alkalimetric Indicator.—Dr. E. Freise.—The author proposes an extract made by digesting 50 parts of the best rasped logwood with 1000 parts of distilled water at 40° for a day, and filtering rapidly.

C. H. Wolff's Colorimeter.—The principle of this instrument is the production of an increase or decrease in the depth of the stratum of liquid under examination until it appears equal in intensity to a standard.

Chemical Nomenclature.—G. Auerbach.—The author complains that one and the same name is often applied to two or more distinct chemical compounds. He asks also by what right is the name cœrulein given to a dye which dissolves in alkalies with a green colour, and which dyes mordanted tissues a beautiful green.

New Tanning Materials.—Dr. A. Schottky.—The author calls attention to the bark of the red and the white mangrove, and especially to that of the mahogany tree, which contains from 28 to 32 per cent of tannin.

La Correspondance Scientifique.

October 14, 1879.

On Telegraphic Lightning Conductors.—W. H. Preece.—From an English source.

Spurious Oidium Americanum in the Vineyards of France.—A biological paper. The author points out the distinctions between the *Oidium Americanum* and other vineyard pests, such as the *Erineum*.

Induction and Thermodynamics.—M. de Mertens.—A historical summary.

Chronicle of the Electric Light.—M. Ch. Varey.—The author maintains that for equal quantities of light the Jablochkoff burner is more economical than gas by 50 to 80 per cent.

Popular Astronomy.—M. Camille Flammarion.—The nature of this letter may be understood from its title.

November 4, 1879.

Transmissibility of Rabies from Man to the Rabbit.—Human saliva is found perfectly capable of propagating this disease.

Transportation of Motive Power.—E. Venelle.—An account of the progress made towards the transmission of power by means of electricity.

The New Chloride of Calcium Battery.—M. Alf. Niaudet.—See p. 240.

Le Textile de Lyon. November 9.

M. A. Perrett gives a tabular statement of the loss sustained by silks of different growths in the removal of the "gum."

M. Jules Imbo describes the various attempts made to produce an artificial silk or to coat the fibre of China grass with a solution of silk waste. The latter operation is to a very considerable extent successful.

Reimann's Färber Zeitung,

No. 41.

A railway official is said to have died from blood-poisoning in consequence of having passed a thread of red woollen yarn through a blister on the sole of his foot. Dr. Reimann points out the improbability of the story.

No. 42.

This issue is chiefly devoted to accounts of the Arnheim and Berlin Exhibitions.

No. 43.

A piece of English calico, according to the *Wollengewerbe*, is said to be composed of:—

Cotton	53·0
Alumina	26·0
Starch	12·0
Fatty matter	2·5
Magnesium chloride	2·0
Zinc chloride	1·5
Calcium chloride	0·5
Water	2·5

Cachon de Laval is said to be capable of spontaneous ignition, which Dr. Reimann sees reason to doubt.

The cochineal harvest in the Canary Islands has suffered greatly from unseasonable rains.

No. 44.

In addition to a number of dyeing receipts, this number gives an article on the signification of patents, and accounts of the Exhibitions at Berlin and Arnheim.

Die Chemische Industrie.

No. 10, October, 1879.

Extraction of Sulphur from Sulphurous Acid and Hydrogen Sulphide.—J. Stingl and Th. Morawski.—Taken from the *Journal für Praktische Chemie*, vol. xx., p. 76.

Examination of Commercial Samples of Albumen.—Cordillot dissolves the samples in 40 parts of water, and notes the quantities of matters remaining insoluble and the consistence of the liquid. He pronounces the Russian blood albumen the best.

Researches on the Colouring Matters of Garancin.—A. Rosenstiehl.—An examination of pseudopurpurin,

purpurin, purpurin-hydrate, alizarin, garancin-orange (munjistin), purpuroxanthin, and hydropurpuroxanthin.

A. E. Mérz proposes to make up pigments with a mixture of 24 parts of glue (isinglass), 534 parts glycerin, 208 water, 208 parts wax, 12½ ammonia, and 12½ resin.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.

No. 69, September, 1879.

This issue contains no chemical matter.

MISCELLANEOUS.

Royal Institution of Great Britain. — General Monthly Meeting, Monday, December 1; the Duke of Northumberland, LL.D., D.C.L., Lord Privy Seal, President, in the chair. Miss Henrietta Maria Adair, Edward Greenhill Amphlett, Esq., M A., Henry Fearnside, Esq., M.B., F.R.C.P., Major Edward Smith Gordon, R.A., and Thomas Henry Sanderson, Esq., were elected members. The following are the arrangements for lectures before Easter, 1880:—

Christmas Lectures.

Professor Tyndall, D.C.L., F.R.S.—Six Lectures on Air and Water; on December 27 (Saturday), 30, 1879; Jan. 1, 3, 6, 8, 1880.

Prof. Edward A. Schäffer, F.R.S.—Ten Lectures on the Physiology of Muscle; on Tuesdays, Jan. 13 to March 16.

H. Heathcote Statham, Esq.—Two Lectures on Modern Architecture since the Renaissance; on Thursdays, Jan. 15 and 22.

Prof. Dewar, M.A., F.R.S.—Eight Lectures on Recent Chemical Progress; on Thursdays, Jan. 29 to March 18.

Prof. T. Rupert Jones, F.R.S.—Three Lectures on Coal; on Saturdays, Jan. 17, 24, 31.

Prof. Ernst Pauer.—Three Lectures on Handel, Sebastian Bach, and Joseph Haydn. With Musical Illustrations. On Saturdays, Feb. 7, 14, 21.

Four Lectures, on History of Literature, on Saturdays, Feb. 28, March 6, 13, 20.

The Friday Evening Meetings will begin on January 16, at 8 p.m. Prof. Dewar, F.R.S., will give a discourse (Studies on the Electric Arc) at 9 p.m. Succeeding discourses will probably be given by Dr. W. B. Carpenter, Prof. J. Marshall, Dr. Huggins, Mr. W. H. Preece, Rev. H. R. Haweis, Mr. F. J. Bramwell, Mr. H. N. Moseley, Dr. C. William Siemens, Profs. Tyndall and Huxley, Lord Reay, Mr. G. J. Romanes, M. Lecoq de Boisbaudran, Mr. W. H. Pollock, Prof. Frankland, Mr. H. H. Statham, Mr. W. Spottiswoode, and Mr. Warren De la Rue. To these meetings members and their friends only are admitted.

MEETINGS FOR THE WEEK.

Monday, 8th.—Medical, 8.
— Royal Geographical, 8.30.
— London Institution, 5.
— Society of Arts, 8. (Cantor Lecture). "Chemistry of Bread and Bread Making," Dr. Graham.
Tuesday, 9th.—Civil Engineers, 8.
— Photographic, 8
Wednesday, 10th.—Society of Arts, 8.
— Microscopical, 8.
Thursday, 11th.—Royal, 8.30.
— Royal Society Club, 6.30.
Friday, 12th.—Astronomical, 8.
— Quekett Club, 8.
Saturday, 13th.—Physical, 3. "A New Form of Resistance Balance for Comparing Standard Coils," J. A. Fleming, D.Sc. "The Graduation of Prof. Hughes' Sonometer," J. H. Poynting. "A Dispersion Photometer," W. E. Ayrton and J. Perry. "The Value of '*g*' at Tokio, Japan," W. E. Ayrton and J. Perry.

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THE CHEMICAL NEWS.

Vol. XL. No. 1046.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 268.)

The metallic character appears more clearly in the members of the even series, while the corresponding members in the odd series rather possess acid properties. Thus there is a marked difference between V, Nb, and Ta of the even series in the fifth group and P, As, Sb, and Bi, although they all give an oxide corresponding to R_2O_5; further, the first-named give acids less energetic than the latter. The members of the even series do not give, as far as is known, any hydrated or volatile metallo-organic compounds like the corresponding members in the odd series. As, among the odd elements, Zn, Cd, As, Sb, Se, Te, Br, I, Sn, Pb, Hg, and Bi can form, in a general way, metallo-organic compounds, we can foresee with certainty that the elements In and Tl, comprised amongst those which have just been cited, will also give metallo-organic compounds, such as $InAe_3$ and $TlAe_3$. Up to the present time there is no member of the even series of the higher groups which has formed a metallo-organic compound. The attempts made by Buckton, Cahours, &c., to prepare $TiAe_4$ by means of $TiCl_4$ have not succeeded, in spite of the great analogy between $TiCl_4$, $SiCl_4$, and $SnCl_4$. If, then, the even elements should give any metallo-organic compounds, these compounds would behave in an altogether different manner to the metallo-organic bodies already known, for the same reason that the hydrogenated compounds of Pd, Cu, Nb have not the same properties as the corresponding compounds of the odd series. It would be difficult to obtain volatile compounds of hydrogen and ethyl with Zr, Nb, Mo, W, and Ur.

It might seem that the establishment of the second series would be in opposition to the general division into odd and even series, because the members of this even series (Li, Be, B, C. N, O, F) possess acid properties, give hydrogenous and metallo-organic compounds (BAe_3, $CAe_4=C_9H_{20}$, NAe_3, OAe_2, FAe), and some of them are gaseous, that is to say, that they behave like the odd elements. But in any case, it is necessary to remark, relatively to this series: 1st. That it is not connected with the eighth group like the other even series are; 2nd. That the difference between the atomic weights of elements of this series and the corresponding atomic weights of the following series is about 16, while the difference for all the other series is from 24 to 28. The difference between the atomic weights of the successive even series is about 46, whilst the elements of the second and fourth series have only a difference in their atomic weights of from 32 to 36.

	Li	Be	B	C	N	O	F	Na	Mg	Al	Si	P	S	Cl
	K	Ca	„	Ti	V	Cr	Mn	Cu	Zn	„	„	As	Se	Br
Difference	32	31	„	36	37	36	36	40	41	„	„	44	46	45

In this manner the apparent anomalies are explained, and the fundamental idea that we have conceived concerning the dependence between the properties of the elements and their atomic weights is but confirmed by these observations. For, since there exists another difference in the atomic weights, the reciprocal relation between the properties of the elements should also be different.

The elements of the second series should not have any properties coinciding with those of the elements in the fourth series, except when they would have atomic weights less than those which they really possess. These differences are still noticed between Na and Cu, Mg and Zn; but they disappear when we compare P and As, S and Se, Cl and Br, elements whose differences of atomic weights and properties remain within ordinary limits. It is because of these differences noticed amongst the elements of the second series that I distinguish them by the name of *typical elements*. We can add Na and Mg to them, independently of H, for reasons which have been mentioned above.

If we *compare* the reciprocal relations of the other analogues with the relations that the compounds of the homologous series have amongst themselves, we see that the typical elements correspond to the initial members of the homologous series, which, as we know, do not possess all the properties of the higher homologues. In the same manner the initial members (H_2O and CH_4O) of the alcoholic series $C_nH_{2n}+2O$ possess many properties peculiar to themselves, which disappear in the higher members.

From what precedes, appertains the isolated independent position of hydrogen, which has the lowest atomic weight. From the nature of the saline oxide H_2O and the salts HX, it ought to belong to the first group; the nearest analogue of hydrogen is sodium, which should be placed in an odd series of the first group. Cu, Ag, and Au are very distant analogues of H. All the five give compounds corresponding to RO and R_2O_2 (H_2O, Na_2O_2,[*] Cu_2O_2; Ag_2O_2, and Au_2O_2). If oxide of copper at the minimum of oxidation is represented by CuO, it is also necessary to represent the preceding peroxides by RO, NaO, AgO, AuO. It is true that CuO forms salts corresponding to CuX_2, while the peroxides, such as AgO,[†] do not give, as far as is known, any salts of this kind. However, Ni, which immediately precedes Cu in the system, and Pd, which immediately precedes Ag, have an analogous difference; Ni gives no salts like NiX_4, while Pd forms salts like PdX_2, although they are not very stable.

Further, we notice, in each even series, from the first group to the eighth, an increase in the quantity of oxygen which can enter into combination with an element; in the series of the eighth group this faculty diminishes as the atomic weight increases (see above), and it attains its minimum for Cu, Ag, and Au; from thence (for Zn, As, for Cd, In, for Hg, Tl) it commences to increase. Therefore Cu, Ag, and Au, as is shown in the second table, occupy two places, one in the first group and the other in the eighth; in the lower forms of combination they correspond to H and Na (first group). This analogy is above all evident in Ag, which needs no other explanation; the analogy of the compounds of suboxide of copper and suboxide of gold with the compounds of oxide of silver is quite as certain; the comparison of the properties of CuCl, AgCl, and AuCl, afford sufficient proof. In spite of a great analogy between the compounds HX and NaX, there exists between the first and the last a series of differences well known to everybody; it calls to mind the differences between carbonic acid and the higher homologues (glycolic acids), which are analogous to it in many respects.

As a noticeable example of the analogy between the compounds of H, Na, and Cu (as suboxides), Ag and Au (also as suboxides), I will give a table of their volumes. (See next column.)

We see that the corresponding members have very nearly equal volumes. Li and K, on the contrary, have in the same form of combination different volumes. It is in this manner that the volume of LiCl=21, of KCl=37,

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[*] It is known that K gives a peroxide KO_2. It would be interesting to further the study of peroxide of lithium, to decide whether its formula is LiO, and if it has not basic properties, even in a small degree. AgO should also be studied in this respect.

[†] We know that I, in reacting on peroxide of sodium, forms Na_2OI_2, which has a composition analogous to that of Cu_2OCl_2.

	Density.	Volume.
HCl	1·27	29
$NaCl$	2·16	27
$CuCl$	3·68	27
$AgCl$	5·55	26
$AuCl$	9·3 ?	25

	Volume.		Volume.		Volume.
Na_2CO_3	43	H_2O	20	H_2SO_4	53
Ag_2CO_3	46	Na_2O	21	Na_2SO_4	54
				Ag_2SO_4	58
HNO_3	41	$NaHO$	19		
$NaNO_3$	39	Cu_2O	25	$NaClO_3$	46
$AgNO_3$	39	Ag_2O	28	$AgClO_3$	44

of $LiNO_3=29$, of $KNO_3=48$, of $Li_2SO_4=50$, of $K_2SO_4=66$. The compounds of K have greater volumes (and a constantly less density) than the corresponding compounds of Na or Li.

(To be continued.)

ON THE NORMAL PARAFFINS.

Part III.[*]

By C. SCHORLEMMER, F.R.S.,
Professor of Organic Chemistry in Owens College, Manchester.

The isomeric monochlorides, obtained from the normal paraffins existing in petroleum, yield by the abstraction of hydrochloric acid a mixture of olefines, one portion of which readily combines with hydrochloric acid in the cold, whilst the other unites with it only on heating.[†]

The chlorides formed in the cold boil with partial decomposition and at a lower temperature than the others, which distil without undergoing any change, and have the general formula—

$$CH_3—CHCl—C_nH_{2n+1}.[‡]$$

They are therefore defined from the olefines of the series—

$$CH_2{=}CH—C_nH_{2n+1}.$$

Similar results have been obtained by Le Bel.[§]

The constitution of the olefines combining with the acid in the cold is not yet known. They are possibly not derived from normal paraffins, but from isomerides, which cannot be separated from the former by distillation. On the other hand, their formation can also be explained without making this assumption. This question can only be decided by using an absolutely pure paraffin.[||]

For this purpose normal hexane from mannite was selected, which possibly might yield three isomeric monochlorides:—

(1.) $CH_3—CH_2—CH_2—CH_2—CH_2—CH_2Cl$
(2.) $CH_3—CH_2—CH_2—CH_2—CHCl—CH_3$
(3.) $CH_3—CH_2—CH_2—CHCl—CH_2—CH_3$.

The formation of the first two has already been proved.[¶] The following seemed capable of determining whether the third is also produced. By the abstraction of hydrochloric acid three hexylenes might be formed:—

Butyl-ethylene—
$CH_3—CH_2—CH_2—CH_2—CH{=}CH_2$
Methyl-propyl-ethylene—
$CH_3—CH_2—CH_2—CH{=}CH—CH_2$
Diethyl-ethylene—
$CH_3—CH_2—CH{=}CH—CH_2—CH_3$.

The first of these does not combine with cold hydrochloric acid; the second is the hexylene obtained from secondary hexyl iodide.[¶] Le Bel and Wassermann have found that cold hydrochloric acid has no action on it, from which it follows that, if normal hexane from mannite yields a hexylene combining with hydrochloric acid in the cold, it could only be diethyl-hexylene, which could be easily identified by conversion into ethyl-propyl carbinol and oxidising it, when only propionic acid should be formed.

This was my programme; the results were, however, quite unexpected.

The hexylene obtained by decomposing the hexyl chlorides was left in contact with cold fuming hydrochloric acid for some weeks. *The whole of it combined, and the hexyl chloride thus formed boiled constantly and without the least decomposition* at 124° to 125°. It was converted into the alcohol, which on oxidation yielded only acetic acid and butyric acid, and consequently is methyl butyl carbinol. We have therefore the remarkable fact that two hexanes exist, which must be regarded as normal compounds, and therefore, according to our present theory, to be identical. This is, however, not the case. I have already, in my first paper, pointed out some other differences existing between the two hexanes, but left the question open whether these are caused by impurities contained in the hexane from petroleum, or whether we have here a case of fine isomerism, for which an explanation has to be found.[*] I believe the results of my present research speak strongly in favour of the latter view.

For several reasons I am inclined to believe that petroleum consists chiefly of an inextricable mixture of isomeric and homologous paraffins, in which, however, the normal hydrocarbons preponderate. This would certainly explain why it is so difficult to isolate from it bodies having a constant boiling-point,[†] but not the differences exhibited by the two hexanes.

A combination of these researches has already been commenced. My friend Thorpe, who has made the most interesting discovery that the terebinthinate exudation of *Pinus Sabiniana* contains a large quantity of normal heptane,[‡] has kindly offered me to join him in the chemical investigation of this hydrocarbon. At the same time we shall compare it with other "normal" heptanes from different sources.

ON THE ACTION OF NUCLEI IN PRODUCING THE SUDDEN SOLIDIFICATION OF SUPERSATURATED SOLUTIONS OF GLAUBER'S SALT.[§]

By CHARLES TOMLINSON, F.R.S.

In this paper the author states the general conclusions at which he has arrived since resuming the study of this subject two years ago.[||] The remarks that are made refer to solutions of the typical salt, sodic sulphate, in the proportions of 6 of salt to 3 of water.

In his first two papers on supersaturated saline solutions[¶] a nucleus is defined as a body that has a stronger adhesion for the salt, or for the liquid of a solution, than subsists between the salt and the liquid. Many examples are given in which oils, fixed and volatile, alcohol, ether, &c., spreading on the surface of the solution, lead to the separation of salt and the solidification of the solution; while if such liquids, instead of spreading, assume a lenticular form, they become inactive, and by shaking the flask with a circular motion are dispersed through the solution in numerous globules, without any immediate nuclear action.

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[*] Abstract of a Paper read before the Royal Society, November 20, 1879.
[†] *Journ. Chem. Soc.*, 1873, p. 319.
[‡] Morgan, *ibid.*, 1875, p. 301.
[§] *Bull. Soc. Chim.* (2), xxviii., p. 460.
[||] *Journ. Chem. Soc.*, 1875, p. 306.
[¶] Hecht, *Deut. Chem. Ges. Ber.*, xi., p. 1152.

[*] *Phil. Trans.*, vol. clxii, p. 119.
[†] *Journ. Chem. Soc.*, 1875, p. 306.
[‡] *Ibid.*, 1879, p. 2,6.
[§] Abstract of Paper read before the Royal Society, November 20 1879.
[||] *Proc. Roy. Soc.*, vol. xxvi., p 523.
[¶] *Phil. Trans.*, 1868 and 1871.

There are several circumstances which favour the action of these liquid nuclei, such as (1) chemically clean flasks and solutions, so as to maintain (2) the surface-tension of the solution as high as possible, in order to spread the oils; (3) bright and clear weather, with strong evaporative force. Under such conditions the oils, &c., usually form films with nuclear action.

But it has been shown that in closed flasks, with special precautions against the entrance of particles from the air, the oils, &c., may be made to spread on the surface of these solutions without any nuclear effect.

The author was led to make a number of observations daily, during some months, on the action of a freshly-distilled volatile oil on solutions of sodic sulphate, and found that during certain winds the oil was active, and that while other winds prevailed it was passive.[*]

It was clear, then, that during some winds a force was present in the air which rendered the oil active; while during other winds, the force being absent, the oil remained passive. He succeeded in identifying this force with ozone; and the point now to be determined is, what is the peculiar function of ozone in rendering oils, &c., active, as nuclei?

It is evident, from the behaviour of ozone on volatile oils exposed to its influence, that its action is an oxidising one, diminishing their cohesion, just as rust weakens the cohesive force of the particles in a bar of iron.

The effect which ozone produces quickly on a volatile oil is produced slowly on the same oil by long keeping. Its cohesive force is so far weakened, if not destroyed, that a drop of it on the surface of a solution no longer tends to assume the lenticular form, or to disperse in globules through the solution. Under such circumstances. since oil adheres much more strongly to salt than to water, and the supersaturated solution, being a highly charged system, capable of yielding to a force that is exerted in the right direction,[†] such an oil is capable of adhering to and separating a portion of the salt, and the action, once begun, is propagated rapidly, until the whole solution is solid.

The action of a foreign nucleus introduced into the cold solution from without, is to determine the formation of the ten-atom or normal salt; but if a solid body be boiled up with the solution, and the covered flask be left to cool to temperatures about and below 40° F., the modified or seven-watered salt will be found clustered about the solid body. An explanation of this may be found in the behaviour of the salt while undergoing solution. Suppose the flask to contain 6 parts of the crystallised, not effloresced, salt and 3 of water. If the heat be applied too strongly the salt gives up its water of crystallisation, and the anhydrous salt is thrown down, and produces violent bumpings of the flask. But if the heat be kept below the temperature of maximum solubility of the salt (about 93° F.) until the whole of it is dissolved, the solution may be raised to the boiling-point and also be cooled down in covered vessels to about 40° F. without any separation of salt. The anhydrous salt now appears to be in solution,[‡] and a solid body previously heated in the solution forms a portion of it, or rather a portion of the flask, and may be regarded as a prolongation of its sides. Under a proper reduction of temperature, crystals of the seven-atom salt will cluster about such a body, but it cannot be said to exert any active nuclear function. It was pointed out by Ziz, as long ago as the year 1809, that solid bodies boiled up with the solution are inactive; and the author has found them to be so when put into the hot or warm solution, and left till cold; and that oils and other liquids, boiled or heated with the solution, become equally inactive. Several observers, who have more or less recently worked on the subject before us, have not attended to this condition, and hence, obtaining negative results, have declared that the oils, &c., have no nuclear action under any circumstances.

If, however, a nucleus from without be introduced into the cold solution, a nucleus that is capable of adhering to the salt and not to the water of the solution, a molecule of the anhydrous salt is thereby set free, and, in the very act of separating, 10 atoms of water enter into combination, and thus determine the solidification of the whole of the solution in the form of the normal salt.[*]

If the nucleus fail to catch one of these saline molecules, as it were, in the nascent state, but disperses through the solution, its effect is to lessen the adhesion between the water and the salt, and a portion of the seven-atom salt is liberated (mostly at the bottom of the vessel, where the solution is richer in salt) provided the temperature be not too high: this effect is also produced by cold alone.

If an essential oil, which acts as a nucleus in determining the formation of the normal salt, be submitted to distillation, the distillate re-assumes its cohesive force, and when added to the solution is no longer active, seeing that whether in the lenticular form or dispersed in globules it has a separate existence of its own, the lens and each minute globule being bound up in their own surface tension, which prevents them from coming into contact with the salt. If, however, the drop of oil spread out into a film upon the surface of the solution, the cohesion is so far weakened that adhesion between it and the salt becomes possible, separation usually takes place, and large crystals of the normal salt mould themselves on the under surface of the film.

If such be the true explanation, it is clear that any other force which diminishes or destroys the cohesive force of the oil must confer upon it the same nuclear property. Consequently a freshly distilled essential oil, mineral naphtha, &c., which are inactive, become active by the addition of a little absolute alcohol, ether, and similar liquids in which they are soluble.

The fixed oils which tend to become rancid through age are also active, and the stearine deposited by them is especially so. Newly refined fixed oils, which are inactive, become active on the addition of a little alkali; but the tendency of potash, soda, and ammonia is to form soluble soaps with the oils, which mingle with the solution often without nuclear action. Lime and magnesia are more manageable. On mixing the oil with one of these, and adding a drop or two to the solution, then inclining the flask nearly horizontally, and rotating it slowly on its axis, these insoluble soaps adhere to the side and form smears, upon which masses of large crystals of the normal salt start into existence in a striking manner, and the solution immediately becomes solid, so that on restoring the flask to its erect position a vertical wall appears, with a solid mass on one side and an apparently empty space on the other.

Some of the solid and semi-solid fats in their natural state, or as they leave the hands of the cook, are admirable nuclei. Such are suet, dripping, fat of bacon and ham, lard, butter, and some others. But in all cases a freshly cut surface acts most effectually, and a fat that sometimes does not act for hours if cut one way, will act instantly if cut at right angles to the former direction. Lard contains a good deal of entangled water: this should be driven off. The lard when cold sometimes acts better when smeared on a clean glass rod than in a small lump.

The action of solid porous nuclei, such as plaster of

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[*] These observations were made at Highgate; others by the sea-side are described in *Proc. Roy Soc.*, No. 196.

[†] See a Paper "On the Function of the Sides of the Vessel in maintaining the State of Supersaturation." *Proc. Roy. Soc.*, vol. xxvii., p. 189.

[‡] See Chemical News (vol. xx., pp. 267 and 277). In Wüllner's experiments on the elasticity of steam, when sodic sulphate was added to the water, the diminution in the elasticity was found to be proportional to the quantity of *dry* salt in solution at temperatures from 10° to 100° C. At the point of maximum solubility of the salt no molecular change occurred, or it would have impressed itself on the curve which represented the elasticity of the steam.

[*] Löwell noticed that when the transparent seven-atom salt is removed from the solution, it becomes opaque and hot in consequence of the fixation of three additional atoms of water. In such case the supersaturated mother-liquor on the surface, and entangled among the crystals, produces, in the absence of a nucleus, a crystal of the normal salt by evaporation, and this acts as a nucleus.

Paris, pumice, &c., in determining the sudden solidification of these solutions admits of easy explanation. When these bodies are moderately absorptive they act by separating water from the solution; but when, by exposure to heat, their absorptive power is considerably increased, they become immediately saturated, not with water, but with a portion of the solution itself, and hence there is no separation of salt. When such an apparently inactive body is exposed to the open air, its absorptive power becomes somewhat diminished by access of moisture, and it is brought into a condition to absorb more water from the solution, instead of the solution itself. In the experiments of Mr. Liversidge and others the porous bodies were thoroughly heated and dried before they were brought into contact with the solution, and this will sufficiently explain the negative results obtained by them in their carefully conducted experiments.

The action of nuclei on the supersaturated solutions of other salts, such as those of alum, zincic and magnesic sulphates, and one or two others, admits of similar explanations; but there are peculiarities belonging to each which need not at present occupy the time of the Society.

The curious condition of supersaturation was first observed by Dr. Black towards the end of the last century, and from that time to the present innumerable notes and memoirs have been written on the subject. Some observers who have treated the subject most elaborately have adopted methods which, by the action of heat and the exclusion of air, have tended to promote the cohesive or adhesive force of the bodies examined by them, and obtaining only negative results, and always a certain result with a crystal of the salt, they have insisted that this is the only nucleus. Others, again, have sought for an explanation in some catalytic or other mysterious force; while a third set of observers have declared it to be a matter of uncertainty or hazard whether a foreign body acts as a nucleus or not. In reviewing the subject and repeating his experiments in various ways, the author sees no reason for withdrawing from the theory which he submitted to the Royal Society eleven years ago, namely, that the action of nuclei is simply mechanical, and is capable of being expressed by the familiar word "adhesion."

THE ACCUMULATION OF NITRIC NITROGEN IN THE UNCHANGED WATER OF AQUARIA.

By H. WILLIAMS JONES, F.C.S.

In many public aquaria, as at the Crystal Palace and Westminster, and also at the very fine one recently opened at the Aston Lower Grounds, near Birmingham, unchanged sea-water is employed; and such water has been found by experience to be fit for an almost indefinite period for maintaining marine animals in health. The principle adopted is to keep the bulk of the water in underground reservoirs, and to constantly pump from them a fresh supply into the show tanks, the delivery of the water being made through a series of fine jets. The great object of a constant supply, delivered in such a manner, being to force air along with fresh cool water into the tanks containing the animals. By that means the water is maintained of an almost constant temperature and even if temporarily rendered cloudy by the presence of decaying fragments of food, &c., the rapid oxidation resulting from the air forced in along with the fresh water from the jets, soon renders the water quite clear. At Brighton and some other places the sea-water is intended to be used for a limited time only, a fresh supply being pumped in from the sea as often as required. Since it would be impracticable for inland aquaria to be supplied even at distant intervals with fresh sea-water, on account of the great cost incurred in collecting and for carriage, the system of unchanged water, has of necessity to be adopted. It occurred to me to examine a sample of water in my possession, which, after being used for eight years in a large public aquarium, was quite bright and appeared to answer perfectly the requirements of the animals, to see how far the nitric nitrogen had accumulated. It was inferred that a very large amount would be present as a result of the oxidation of the organic matter thrown off by the animals, or left in the water in the form of uneaten and unremoved dead food. As anticipated, a very large excess over what exists in actual sea-water fresh from the ocean was detected and the following figures will show the difference between the aquarium-water and sea-water taken about the same date from Brighton, and which fairly represents the amount present naturally in sea-water.

	Nitric Nitrogen. Parts per 100,000.
Recent sea-water	0·0325
Aquarium-water	12·0498

In all well-stocked aquaria the number of living animals of a large size in relation to the bulk of water is greatly in excess of what exists in Nature; and the food of such animals kept in confinement instead of being produced in the water in which they live is received from an outside source in the shape of food formed in the ocean. The nitric nitrogen is formed in aquaria faster than it is removed by vegetation, which is usually limited to *confervæ*, and so it accumulates.

ON THE VAPOUR-DENSITIES OF PEROXIDE OF NITROGEN, FORMIC ACID, ACETIC ACID, AND PERCHLORIDE OF PHOSPHORUS.

By J. WILLARD GIBBS.

(Continued from p. 236.)

Acetic Acid.—For this substance the densities have been calculated by the formula—

$$\log.\ \frac{2{\cdot}073\ (D-2{\cdot}073)}{(4{\cdot}146-D)^2}=\frac{3520}{t_c+273}+\log p-11{\cdot}349, \qquad (12)$$

the constants 3520 and 11·349 being derived from the determinations of Cahours and Bineau, which with those of Horstmann and Troost are given in Table IV. The experiments of Cahours and Horstmann were made under atmospheric pressure, those of Horstmann* by the method of Bunsen, those of Cahours presumably by the method of Dumas. The numbers in the first column of the densities observed by Cahours are taken from the twentieth volume (1845) of the *Comptes Rendus*, except a few cases distinguished by parentheses, which are taken from the preceding volume (1844). The numbers in the second column are taken from his "Leçons de Chimie générale élementaire," 1856. These numbers seem to be based in part upon new experiments, and in part upon a revision of the observations recorded in the *Comptes Rendus*, the calculations being carried out to another figure of decimals. They are therefore entitled to a greater weight than the numbers of the preceding column.

The agreement of the formula with the numbers given in the "Leçons de Chimie" is very good, the greatest divergences being 0·080 at 190° and 0·062 at 180°. But at 190° the table in the *Comptes Rendus* agrees precisely with the formula, and at 171° (the next experiment) it shows a divergence in the opposite direction. The next divergencies in the order of magnitude are −·033, −·036, −·032 at 219°, 231°, 240° respectively. Here the table in

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* *Liebig's Annalen*, suppl. vi., p. 65.

TABLE IV.—ACETIC ACID.

Experiments of Cahours, Horstmann, Bineau, Troost.

Temperature.	Pressure.	Density calc. by eq. (12).	Density observed. Cahours.		Horstmann.	Excess of observed Density. Cahours.		Horstmann.
			C. R.	Lecons.		C. R.	Lecons.	
338	(760)	2·077	2·08			·00		
336	(760)	2·077		2·082			+·005	
327	(760)	2·078	2·08	2·085		·00	+·007	
321	(760)	2·079	2·08	2·083		·00	+·004	
308	(760)	2·081		2·085			+·004	
300	(760)	2·082	2·08			·00		
295	(760)	2·084		2·083			−·001	
280	(760)	2·089	2·08			−·01		
272	(760)	2·093		2·088			−·005	
254·6	747·2	2 105			2·135			+·030
252	(760)	2·108		2·090			−·018	
250	(760)	2·111	2·08			−·03		
240	(760)	2 122		2·090			−·032	
233·5	752·8	2·132			2·195			+·063
231	(760)	2·137	(2·12)	2·101		(−·02)	−·036	
230	(760)	2·139	2·09			−·05		
219	(760)	2·165	2·17	2·132		+·01	−·033	
200	(760)	2·239	2·22	2·248		−·02	+·009	
190	(760)	2 298	2·30	2·378		·00	+·080	
181·7	749·7	2·359			2·419			+·060
180	(760)	2·376		2·438			+·062	
171	(760)	2·466	2·42			−·05		
170	(760)	2 477		2·480			+·003	
165·0	754·1	2·534			2·647			+·113
162	(760)	2·575		2·583			+·008	
160·3	751·6	2 594			2·649			+·055
160	(760)	2·601	2·48			−·12		
152	(760)	2·716	(2·72)	2·727		(·00	+·011	
150	(760)	2·747	2·75			·00		
145	(760)	2·826	(2·75)			(−·08)		
140	(760)	2·910	2·90	2·907		−·01	−·003	
134·3	748·8	3·001			3·108			+·107
131·3	754·1	3·055			3·070			+·015
130	(760)	3·082	3·12	3·105		+·04	+·023	
128 6	752·9	3·103			3·079			−·024
125	(760)	3·168	3·20			+·03		
124	(760)	3·185		3·194			+·009	
			Bineau.		Troost.	Bineau.		Troost.
132	757	3·05	(2·86)			(−·19)		
130	59 7	2·31			2·12			−·19
130	30·6	2·21			2·10			−·11
129	633	3·03	(2·88)			(−·15)		
36·5	11·32	3·63	3·62			−·01		
35·0	11·19	3·65	3·64			−·01		
30·0	6 03	3·61	3 60			−·01		
28·0	10·03	3·75	3·75			·00		
24·0	5·75	3·71	3·70			−·01		
22·0	8 64	3·82	3 85			+·03		
22	2·70	3·59	3 56			−·03		
21·0	4·06	3·70	3·72			+·02		
20·5	10·03	3·86	3·95			+·09		
20·0	8·55	3·84	3 88			+·04		
20·0	5·56	3·77	3·77			·00		
19·0	4·00	3·73	3·75			+·02		
19	2·60	3·65	3·66			+·01		
12·0	5·23	3·88	3·92			+·04		
12	2 44	3·77	3·80			+·03		
11·5	3·76	3·84	3 88			+·04		

the *Comptes Rendus* agrees substantially with that of the "Leçons," but the experiments of Horstmann show a divergence to the opposite direction. In fact, the three columns of observed densities nowhere agree in the direction of their divergence from the formula.

The somewhat decided differences between the results of Horstmann and those of Cahours may be due in part to the different methods of observation, especially to the entirely different manner of applying the heat and measuring the temperature. But the higher values obtained by Horstmann cannot be accounted for by too short an exposure to the source of heat, for his experiments were made with decreasing temperateres.

The determinations of Bineau are taken from the same sources as those on formic acid, the earlier determinations being distinguished as before by parentheses. One of these (at 132°) was made by the method of Dumas, the other by that of Gay-Lussac. The smallness of the observed densities appears due to the presence of water (An acidimetric test gave 295 parts of acid in 306.) The

TABLE V.—ACETIC ACID.

Experiments of Naumann.

		Temperature.								
		78°.	100°.	110°.	120°.	130°.	140°.	150°.	160°.	185°.
A	Pressure		393·5	411	432	455	477	498·5		565
	Density calculated		3·39	3·23	3·06	2·90	2·75	2·61		2·28
	Density observed		3·44	3·31	3·14	2·97	2·82	2·68		2·36
	Excess of density observed..		+·05	+·08	+·08	+·07	+·07	+·07		+·08
B	Pressure		342·3	359·3	377·5	398·5	417·5	436·5		495
	Density calculated		3·35	3·18	3·02	2·85	2·70	2·57		2·26
	Density observed		3·37	3·22	3·06	2·89	2·75	2·63		2·31
	Excess of density observed..		+·02	+·04	+·04	+·04	+·05	+·06		+·05
C	Pressure		258							382
	Density calculated		3·26							2·22
	Density observed		3·17							2·25
	Excess of density observed..		−·09							+·03
D	Pressure		232		252	274	287·5	300		335
	Density calculated		3·23		2·87	2·72	2·58	2·46		2·21
	Density observed		3·12		2·94	2·68	2·54	2·44		2·23
	Excess of density observed..		−·11		+·07	−·04	−·04	−·02		+·02
E	Pressure	164	186	197	209	221	232	243	253	269
	Density calculated	3·53	3·15	2·97	2·81	2·65	2·52	2·41	2·32	2·18
	Density observed	3·41	3·06	2·91	2·75	2·61	2·50	2·40	2·31	2·22
	Excess of density observed ..	−·12	−·09	−·06	−·06	−·04	−·02	−·01	−0·1	+·04
F	Pressure	149	168			201				
	Density calculated..	3·50	3·12			2·62				
	Density observed	3·34	3·01			2·56				
	Excess of density observed ..	−·16	−·11			−·06				
G	Pressure	137	156	166·5	180	188	199	208·2		230
	Density calculated	3·48	3·09	2·92	2·75	2·60	2·47	2·37		2·17
	Density observed	3·26	2·98	2·81	2·61	2·50	2·40	2·29		2·14
	Excess of density observed ..	−·22	−·11	−·11	−·14	−·10	−·07	−·08		−·03
H	Pressure	113	130	138·5	149	157·5	168·2	175		191·5
	Density calculated	3·42	3·03	2·85	2·69	2·55	2·43	2·33		2·15
	Density observed	3·25	2·94	2·78	2·60	2·47	2·32	2·26		2·13
	Excess of density observed..	−·17	−·09	−·07	−·09	−·08	−·11	−·07		−·02
J	Pressure	80	92	98·5	106	112·5	117·3		129·2	
	Density calculated	3·32	2·91	2·73	2·58	2·45	2·35		2·21	
	Density observed	3·06	2·76	2·61	2·46	2·34	2·27		2·11	
	Excess of density observed..	−·26	−·15	−·12	−·12	−·11	−·08		−·10	
K	Pressure	66	77·7	84	89·5	93	98	103		110·5
	Density calculated	3·26	2·85	2·68	2·53	2·40	2·31	2·24		2·12
	Density observed	3·04	2·66	2·49	2·37	2·32	2·24	2·16		2·11
	Excess of density observed ..	−·22	−·19	−·19	−·16	−·08	−·07	−·08		−·01

other experiments were made with the same apparatus which was used with formic acid, and show even greater regularity in their results than the experiments with that substance. Only in one case is the influence of proximity to saturation seen, viz., at 20·5° and 10·03 m.m., the pressure of saturated vapour at this temperature being about 12·7 m.m.* In the remaining fifteen observations of this series, notwithstanding the very low pressures employed from 2·44 to 11·32), the greatest difference between the observations and the formula is 0·04, and the average difference 0·02.

The two observations by Troost† were made by the method of Dumas, but at pressures very low for this method. The results obtained differ considerably from the formula, but not so much as in the case of his experiments at low pressure with peroxide of nitrogen.

Table V. contains the experiments of Naumann§ on acetic acid. These consist of ten series (distinguished by the letters A, B, C., &c.) of observations by Hoffmann's method.‖ The temperatures of the observations in the different series are for the most part the same, so that for each temperature we have observations through a wide range of pressures. Within each compartment of the table are given in order the pressure of an experiment, the density calculated by equation (12), the observed density, and the excess of observed density, the temperature of the experiment being given at the head of the column. These experiments, taken by themselves, seem to show an effect of pressure upon the density about one-third greater than is indicated by the formula. But the divergences (of which the greatest is 0·26 and the average 0·085) are not large in view of the fact that the experiments were undertaken rather with the desire of obtaining a great number of observations with moderate labour than with the intention of attaining the greatest possible accuracy.

The quantity of acid diminishes somewhat regularly from 0·2084 grm. in series A to 0·0185 in series K. The volume, which was 154 c.c. in the experiment at 185° in series A, diminishes in the successive series, and in the same series with diminishing temperature to 69·6 c.c. in the experiment at 78° in series K. It is worthy of notice that the greatest deviations from the formula occur where the liability to error is most serious with respect to pressure (which was measured without a cathetometer), to volume, and to the quantity of acid.

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* This number is obtained from data given by Bineau by the same kind of interpolation which was used for formic acid.

† *Comptes Rendus*, vol. lxxxvi. (1878), p. 1395.

§ *Liebig's Annalen*, vol. clv., s. 325.

‖ This is a modification of the method of Gay-Lussac, in which the heat is supplied by a vapour-bath.

Far more serious than the absolute amount of these divergences is the regularity which they exhibit. But it must be remembered that the observations are by no means entirely independent, and many sources of possible error, such as the calibration of the tube and the determination of the quantity of acid, might affect the results with considerable regularity.

Only to a slight degree can the divergences from the formula be accounted for by an insufficient exposure to the temperature of the experiment. The observations, except those at 78°, were made with increasing temperatures, and the greatest divergences from the formula are not in the positive direction. Yet the positive divergences occur where we should most expect to find them if they were due to this cause, viz., in the series in which the greatest quantities of acid were used, and in cases in which the temperature seems to have been raised at once an usual number of degrees. (See especially the observation at 120° in series D, and in general the observations at 185°, which exhibit, if not a positive, at least a diminution of negative excess.) In the observations at 78° which were the last of each series, and therefore followed a fall of temperature from 185°, we find in some cases, especially in series G, H, and J, a negative divergence much greater than in the other determinations of the same series, and which appears to be referable to this circumstance.

(To be continued.)

SPECTROSCOPIC INVESTIGATIONS.

As previous researches of G. L. Ciamician have shown, chemically related elements have homologous spectra; that is, the individual spectra of the elements of any given group differ from one another only in having their lines displaced towards one end or the other of the spectrum. In the course of a comparative investigation of the spectra of the metals of the alkaline earths, Ciamician has observed phenomena which are adapted to furnishing an explanation of these remarkable relations between the spectra of related elements. When the spectra of the metals of the alkaline earths are produced by allowing the induction spark to pass between the metals (as electrodes) with inserted Leyden jar in an atmosphere of hydrogen, spectra are obtained which show the homology of the lines very beautifully. The spectrum of magnesium, however, can not be compared with the spectra thus obtained, because it does not contain the less refrangible lines. If the jar is removed, or if a weaker battery and a smaller induction coil is used, all the lines in the red and yellow field in the spectra of calcium and strontium become less intense, and spectra are obtained which are very similar to that of magnesium. If the less refrangible part of the spectrum of the group of metals of the alkaline earths—that part which is visible only at a high temperature, corresponding to a high electric tension—is compared with the less refrangible half of the complete oxygen spectrum, it is noticed that these two half-spectra exhibit a remarkable similarity (homology). From this it would follow that the spectrum of the group of the metals of the alkaline earths appear to be made up of that of magnesium, and of the less refrangible half of the oxygen spectrum. As it is known that the atomic weights of barium, strontium, and calcium can be made up of the atomic weight of magnesium and of oxygen ($24+16=40$ [calcium], $24+4\times16=88$ [strontium], and $24+7\times16=136$ [barium], experiments were undertaken to discover whether these remarkable relations in the spectra have any real significance. The author has shown that there exists the same kind of relation between the spectra of carbon and of nitrogen and that of cyanogen, and between the spectra of carbon and of oxygen and the spectrum of carbon monoxide, as that observed between the spectra of magnesium and of oxygen and that of the group of the metals of the alkaline earths. It can hence be said that in all probability the homology of the spectrum lines of chemically related elements depends upon the fact that, in accordance with the regularities in the atomic weights noticed by Mendelejeff, the elements of such natural groups consist of the same components.—(*Wiener Sitzungsberichte*, 79, II. *Abth.*)—*American Chemical Journal.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 4, 1879.

Mr. Warren De la Rue, President, in the Chair.

The following certificates were read for the first time:—J. C. Evans, W. H. Glazier, K. W. Hedges, R. Howell, J. Hogarth, J. McCarthy, A. K. Miller, W. O. Prosser. An election of Fellows was to have been held, but as less than forty Fellows were present the ballot could not be taken.

The President expressed a hope that all members would endeavour to be present at the next meeting (Dec. 18), when, if possible, the ballot would take place.

The following papers were read:—

"*The Comparative Value of Different Methods of Fractional Distillation*," by F. D. Brown. When a fractional distillation is carried out on a large scale either or both of two well-defined processes can be used. In the first, "washing," the mixed vapours are passed through several layers of liquid obtained by their own partial condensation; in the second, "cooling," the mixed vapours are partially condensed by allowing radiation to take place or by passing them through a coil kept at a given temperature. In both processes the liquids of highest boiling point are kept back, and a better distillate is accordingly obtained. A possible explanation of the success of the first process is that by obstructing the passage of the vapour the successive layers of liquid give it more time to cool. From this point of view the two processes are identical. In the present paper the author has endeavoured to determine whether there is any essential differences between "washing" and "cooling" or not. The mixture employed throughout these experiments was the one used by the author in his previous research, and consisted of carbon disulphide and benzene. The dephlegmator advocated by Linnemann, Bel and Henninger, &c., was first compared with a glass tube 690 m.m. long, inclining gently upwards, exposed freely to the cooling influence of the atmosphere, &c. As a result of several experiments it was found that the distillation with the long cooling tube yielded slightly better results than that in which the vapour was washed by passing through the dephlegmator, and that both the dephlegmator and the cooling tube produced better distillates than the retort or the flask with T-piece usually employed. These results were to some extent, however, vitiated by the fact that the distillations were not carried out in equal times, and in order to render the results more strictly comparable the author constructed a long glass tube, and fitted it up with a movable series of disks of wire gauze (each disk containing a short brass tube, trapped at the bottom to prevent the vapour passing up the tube instead of through the layer of liquid condensed on the wire gauze), so that this tube could be used either as a simple cooling-tube, or by inserting the disks could be converted into a dephlegmator. Great care was taken to make the times of the distillation as equal as possible. As a result of these experiments the author concludes that "washing" and "cooling" are not identical processes, that the dephlegmator has a special value, and gives better results, other things being equal, than the simple cooling-tube. The author then contrived a more exact and delicate process of cooling, by means of which the still-head could be kept at the lowest possible temperatures compatible with the passage of vapour into the condenser. This was effected by passing the worm of the still through a strong copper box, which is partly filled with a liquid boiling about the temperature desired. The vapour from this boiling liquid is condensed in a worm which returns the liquid to the box, the box, worm, &c., being air-tight, and constructed of stout copper. The final adjustment of temperature was obtained by connecting this air-tight system with a pump, so that the pressure under which the liquid boiled in the box could be varied at will. By this means the vapour round the still-head could be kept at a constant temperature for an indefinite period, and could be varied without much trouble by alteration of the pressure. By using this apparatus, and charging the box with carbon disulphide, and the still with a mixture containing 42·69 per cent of CS_2, a distillate was obtained containing in two experiments 97 to 99 per cent of CS_2. The author also tested the apparatus by distilling commercial benzene and separating almost pure benzene. Thus 1100 c.c. of a very impure sample gave (the still-head being kept at 81°) at 80·4°, 155 c.c.; 80·8°, 176 c.c.; 81°, 180 c.c.; 82°, 191 c.c. After 500 c.c. had distilled over the experiment was stopped. A sample of the residue distilled as follows:—At 95°, 80 c.c.; 100°, 130 c.c.; 105°, 158 c.c.; 110°, 186 c.c. The paper contains tables of the details of the experiments, curves showing the compositions of the distillates, and drawings of the apparatus.

Dr. ARMSTRONG said that as far as he knew no one had previously compared the values of these two processes of washing and cooling from a scientific point of view. He could confirm Mr. Brown's statements as to the importance of the rate of distillation and the extent of cooling surface. He did not think that fractional distillations of homologous bodies, the vapours of which seemed, so to speak, to hang together, were of much value unless large quantities were employed.

Mr. NEISON thought that a separation could be effected by fractionally distilling small quantities. He had used a very simple apparatus with good results. It consisted of a flask, the neck being closed with a cork, through which passed a tube ending inside the flask in a bulb, with a drawn-out and turned-up beak.

The CHAIRMAN remarked that he had worked on the same principle as that carried out so completely by the author; but instead of surrounding the still-head with a vapour of constant temperature, a thermometer was inserted in the still-head, and the temperature carefully watched.

Mr. BROWN did not think that any hanging together of vapours took place. In his opinion, small quantities could be successfully manipulated by using an apparatus of small size.

The next paper was read by Mr. MUIR, "*On the Influence Exerted upon the Course of certain Chemical Changes by Variations in the Amount of Water of Dilution*," by M. M. P. MUIR and C. SLATER. The authors have studied the influence of the addition of water on the reactions which ensue when solutions of (1) calcium chloride and sodium carbonate, (2) strontium chloride and sulphuric acid, and (3) barium chloride and potassium oxalate are respectively mixed at various temperatures and for various times. The two solutions under experiment were mixed, allowed to stand for the required time, and the precipitate formed estimated by filtering or by pipetting and titrating some of the clear supernatant liquid. In the first reaction the amount of chemical change decreases regularly as the dilution increases; in the second and third various irregularities occur, which the authors have investigated in detail. The paper is lengthy, contains numerous and elaborate tables and curves, without which the results cannot be given intelligibly. The authors continue—Every chemical system appears to tend towards that condition of equilibrium which is marked by the greatest loss of energy. This tendency may be arrested in various ways, *e.g.*, by impressing upon the system what may perhaps be described as an artificial state of equilibrium. Thus, the condition of most stable equilibrium for a system originally consisting of barium chloride and potassium oxalate would be that in which barium oxalate and potassium chloride are produced; but by adding much water a portion of the reacting molecules is, according to the hypothesis of the authors, loaded with water of hydration. In this loading energy is lost, but the loss is less than that which would occur were molecules of barium oxalate and potassium chloride formed. The system is therefore unstable, but a certain degree of stability is impressed upon it by the presence of a large mass of one of the products of the dissociation of the complex and unstable hydrated molecules. Thus a system in a state of strain is produced: a small force may be sufficient to relieve the strain, and the relief may be attended with a rapid re-arrangement of the parts of the system. Accordingly the authors found that small physical differences, such as the roughness or smoothness of a beaker, filtering instead of pipetting, &c., had a large influence in dilute solutions. The authors conclude with the hypothesis that the amount of chemical change which occurs when barium chloride and potassium oxalate are mixed in the proportion of 1 : 1 molecule is irregularly affected by the mass of water of dilution present, because the entire system is brought into a state of strain due to the stress between its parts, and that the principal forces of which this stress is compounded are,—the force tending to produce cryohydrates and other hydrated molecules, the force tending to split up these molecules, and the force tending to separate and so to impart greater mobility to the chemically active molecules of the system.

Mr. MUIR then read a paper "*On the Influence of Temperature upon the Decomposition of Barium Chloride by Potassium Oxalate in Aqueous Solutions.*" In concentrated solutions temperature has but little influence; with more dilute solutions the first increase of about 20° causes a marked increase of action, after this the influence of temperature is more regular; with still more dilute solutions increase of temperature causes at first a slight increase, then a rapid increase of action, until a point is reached, after which further increase of temperature but slightly affects the amount of chemical change; with very dilute solutions the influence of temperature again becomes nearly regular.

Mr. NEISON showed, by the aid of some mathematical formulæ, that for the lower temperatures a longer period of time should be given, otherwise the results obtained would not be comparable with those obtained at the higher temperatures.

The next paper was read by Dr. F. R. JAPP, "*On α- and β-Phenanthrene Carbonic Acids.*" The author has already described with Dr. Schultz (*Deuts. Chem. Gesel.*, x., 1661) the alpha acid; he has since prepared it in a purer state, and finds its melting-point to be 266° instead of 260°. This acid was prepared from crystallised calcic phenanthrene sulphonate by converting the latter into the sodium salt, distilling the dry sodium salt with potassic ferrocyanide, and saponifying the nitrile thus obtained. In the preparation of the calcic phenanthrene sulphonate much dark coloured syrupy mother-liquor was left. This mother-liquor was subjected to the same processes, which had yielded α-phenanthrene carbonic acid from the crystallised salt, in the hope that the corresponding phenanthrene carbonic acid might be more easily purified than the syrupy sulphonate; 80 grms. of crude acid were thus obtained from 2 kilos. of commercial phenanthrene. After considerable difficulty the acid was purified by recrystallising it as a sodium salt. By distillation with soda lime phenanthrene was obtained, being identified by its melting-point, picric acid double compound, and the quinone obtained by oxidation. By oxidation with chromic anhydride in acetic acid phenanthrene quinone was formed. The author has tabulated a comparison of the salts of the α and β acids. The α acid crystallises from hot glacial acetic acid in colourless curved blades; melts at 266°. The β acid crystallises in stellate groups, melting at 250° to 252°. The α sodium salt crystallises with 4 mols. of water in colourless pointed blades; the β salt with 5 mols. of water in rhomboidal laminæ. The α barium salt crystallises with 7 mols. of water in long flexible needles; the β barium salt with 6 mols. of water in long brittle rectangular laminæ. In conclusion the author enters at some length into a theoretical consideration as to the constitutional formula of phenanthrene, which, in his opinion, consists of three benzene nuclei, one of which shares four adjacent carbon atoms with the two others—one ortho pair with each,—and phenanthrene may thus be derived from naphthalene by a repetition of the process by which the latter hydrocarbon is derived from benzene.

After some remarks by Dr. Armstrong, to which Dr. Japp briefly replied,

The Secretary read a paper "*On some Derivatives of Phenyl-acetic Acid*," by P. Philipps Bedson. This paper contains an account of the separation of para and ortho-nitro-phenyl-acetic acids, both of which are crystalline substances; the former melts at 150° to 151°, the latter at 137° to 138°. Also of para- and ortho-bromo derivatives, which crystallise from water in white needles; the former melts at 114° to 115°, the latter at 103° to 104°. A dibromo-phenyl-acetic acid has also been prepared by the long-continued action of bromine on mono-bromo-phenyl-acetic acid in sunlight; it crystallises in white needles, melting at 114° to 115°. A more detailed account is given of the bromo-nitro-phenyl-acetic acids and the corresponding brom-amido acids, short notices of which have appeared in the *Berichte Deuts. Chem. Gesell.*, x., 530 and 1065. A third isomeride has been obtained with these substances by nitrating crude bromo phenyl-acetic acid. This β-bromo-nitro-phenyl-acetic acid crystallises from glacial acetic acid in small transparent prismatic needles, melting at 162°; yielding by reduction β-brom-amido-phenyl-acetic acid, melting at 186°.

The Society then adjourned to December 18, when the following paper will be read:—"On the Specific Volume and Density of Water of Crystallisation," by T. E. Thorpe. A ballot for the election of Fellows will also be held.

NOTICES OF BOOKS.

Blowpipe Analysis. By J. Landauer. Authorised English Edition, by J. Taylor and W. E. Kay. Pp. x. and 161. London: Macmillan, 1879.

We think that this is, on the whole, distinctly the clearest, most systematic, and most useful students' laboratory book on the employment of the blowpipe in chemical and mineralogical analysis. It includes the determination of artificial as well as natural inorganic compounds, and so differs from many other treatises on the blowpipe. The arrangement of the reactions obtained in tabular forms admitting of immediate inspection is carried to a considerable degree of completeness in this compact volume. A good many novelties in the way of apparatus and reagents are included amongst the descriptions, and take their place duly in the systematic course. Such additions have been inserted, however, only after repeated trials have proved their utility; so here are to be found Ross's aluminium plate support and Fletcher's miniature self-acting blowpipe; the employment of gold granules for detecting nickel and cobalt; and the use of hyposulphite of sodium and oxalic acid as a mixture for obtaining in the dry way characteristic metallic sulphides. Here are descriptions of flame-colourations as produced by Bunsen's methods; some condensed instructions as to spectrum analysis are also given. The book, indeed, so far as its object and scope allowed, is complete as well as systematic. Its contents naturally group themselves into five chapters, the first treating of blowpipe apparatus and reagents, and the second of the actual operations and reactions in blowpipe testing. Then succeeds a chapter entitled "Special Examination for certain Elements in Combination," each element being studied in succession in its behaviour with the several tests. Chapter IV. gives a systematic course of analysis, while the remainder of the volume is devoted to the gathering up of the various experiments, observations, and inferences noted in preceding chapters into the form of tabular statements, and into condensed views of the behaviour of certain groups of compounds.

The book is carefully printed: indeed, we have detected but one misprint, ludicrous enough but of no importance, to be found on page 27, where the flame colouration of selenium is given as "corn *flour* blue" instead of "corn flower blue."

Report on a Preliminary Investigation of the Properties of the Copper-tin Alloys, made under the Direction of the Committee on Metallic Alloys. United States Board, to test Iron, Steel, and other Metals. By R. H. Thurston, Chairman in the Mechanical Laboratory of the Stevens Institute of Technology. Washington: Government Printing Office.

Widely as metallic alloys have been employed in the arts, and frequently as they have been made the subjects of scientific research, our knowledge of them is still but fragmentary. Great merit, therefore, belongs to the United States Board for testing metals, and to their Committee on metallic alloys for undertaking the extensive and thorough going series of investigations, of which merely an instalment is recorded in the present volume.

The task undertaken by Prof. Thurston and his colleagues is very clearly defined. They have operated not on alloys formed of chemically pure materials and combined with all the precautions of the laboratory, but on such as are made of ordinary commercial metals by procedures practicable on the large scale. If we remember how small a proportion of some foreign bodies may seriously modify the nature of an alloy, we must admit that they have taken the right course for a series of experiments whose aim was purely practical.

With the chemical properties of the alloys, such as their powers of resistance to air, water, corrosive vapours, &c., they have not concerned themselves. The points determined have been the resistance of the alloys to transverse, tensile, torsional, and compressive stress. It has been ascertained that a comparatively limited group of compounds, extending from gun metal on the one hand to Muntz metal on the other, includes all that are really valuable. Alloys containing more than 27·5 per cent of tin are valueless for any purposes in which strength is requisite. The results of all the experiments are brought very clearly under the eye in a series of 21 graphic illustrations. Another important feature of the work is a set of photographs representing the ends of the fractured bars of metal, and showing more clearly than could be done by words the changes they have undergone from the strains applied. As an appendix there is a selection of papers by former authorities, both on the chemical and mechanical properties of alloys, and a list of the writers quoted.

Prof. Thurston and his coadjutors are engaged with similar researches on the alloys of copper and zinc, and on the triple compounds of copper, zinc, and tin. On the great utility of this report there can be no necessity for us to enlarge.

Crystalline Chlorophyll.—A. Trécul.—Referring to the paper of M. Arm. Gautier (*Bulletin de la Soc. Chimique*, xxviii., p. 147), the author states that as early as 1865 (*Comptes Rendus*, lxi., pp. 435, 436), he described such green crystals which he had seen formed directly from granules of chlorophyll.—*Comptes Rendus.*

CORRESPONDENCE.

ANALYSIS OF BOILER FEED-WATERS.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xxxix., p. 5, there appeared a scheme for the analysis of boiler feed-waters, by Mr. W. F. K. Stock, which commended itself to me as being a great advance upon the old method of giving the "temporary" and "permanent" hardness, and as being much more rapid and practical than the tedious method of resorting to a complete mineral analysis. There is, however, one important statement made, which I have not seen elsewhere, viz., that "*Calcium sulphate is practically insoluble at a pressure of one atmosphere of steam*," and consequently should be debited to the salts precipitable in a steam boiler. Permit me to ask Mr. Stock, through the medium of your columns, if he will favour me with the nature of any evidence he may have at hand in support of this?

Naturally one would resort to the analysis of the scale from a boiler fed with water rich in SO_4Ca for information on this point, but unfortunately I have not such at hand. I may, however, mention that some time ago I found the incrustation from a tea-kettle to yield CO_2 equal to 94·16 per cent of CO_3Ca; and some scale from a steam boiler gave $CO_2 = 71{\cdot}44$ per cent and $SO_4Ca = 3{\cdot}66$ per cent only, the rest being chiefly organic matter and sand. The water producing the above contains about 8 grains of carbonate and 4 of sulphate of lime, but the boiler-water was taken from a river, hence the dirt it contained.—I am, &c.,

J. Bacon.

Derby, December 4, 1879.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 21, November 24, 1879.

Heat of Formation of Ammonia.—M. Berthelot.—The author remarks that the heat of formation of ammonia, that of water, of carbonic acid, and of hydrochloric acid constitute the four most important data of thermo-chemistry. The three latter may be regarded as approximately known. For the formation of ammonia, dissolved and gaseous, he adopts the numbers +21·0 and +12·2.

Researches on Nitrification.—T. Schlœsing and A. Muntz.—The authors have shown that natural nitrification may be considered as the result of a phenomenon analogous to fermentations, but that the oxidation of the nitrogen is not produced in a general manner by the organisms which are the common agents of the combustion of organic matter, but must be ascribed to a special organism. They have taken dilute alkaline solutions containing the necessary mineral matters, an ammoniacal salt, and organic matter. These liquids, after being heated under suitable conditions to 110°, remained without change for an unlimited time. But on allowing the access of atmospheric oxygen the formation of nitrates set in, and on examination with the microscope minute organisms were detected. The nitric ferment does not possess the power of resistance observed in some of its congeners. It is killed by exposure for ten minutes to a temperature of 100. Sewage and similar liquids are generally rich in the nitric ferment, which assists, therefore, in their purification. It is also very abundant in vegetable earth, and generally in arable land.

Constitution of Dibromated Ethylen.—E. Demole.—The author seeks to establish the place of the two atoms of bromine with a view of deciding whether this compound is symmetric or asymmetric.

New Method for the Accurate Analysis of Commercial Potash.—B. Corenwinder and G. Contamine.—The authors add to the portion taken for analysis a slight excess of hydrochloric acid, and then, without taking any notice of the possible presence of sulphuric acid, silica, or phosphoric acid, they evaporate in the water-bath, after having added a sufficiency of platinum bichloride. The potassium chloro-platinate thus obtained is digested with alcohol at 95°, mixed with ether, and washed in the ordinary way with the same liquid. When this operation is complete, boiling water is poured upon the filter by means of a pipette, till the chloro-platinate is entirely dissolved, and the filtered liquid is collected. Water containing sodium formiate is then heated, and whilst it is boiling the preceding solution of potassic chloro-platinate is carefully poured into it by degrees. In a few moments the platinum is thrown down as a black powder, which merely needs to be washed, dried, heated to redness, and weighed in order to find the quantity of potassa present in the sample.

Bulletin de la Société Chimique de Paris,
Nos. 8 and 9, Nov. 5.

Various Thermo-Chemical Data.—M. Berthelot.—The author has determined the formation heat of cyanogen and of diamylen, the heat of fusion of glycerin and the specific heat of glycerin.

The Elimination of Bromine from Bromo-citraconic Acid and a New Organic Acid.—M. E. Bourgoin.—Already noticed.

Solubility of Benzoic and Salicylic Acids.—M. E. Bourgoin.—At 0° one part of benzoic acid requires for solution 588 parts of water, and 1 part of salicylic acid requires 666 parts.

The rest of this issue consists of extracts from other journals, which have been or will be noticed under their respective heads.

No. 10, December 5, 1879.

Hydrochlorate of Hydrogen Phosphide.—J. Ogier.—The author has obtained this compound by compressing and refrigerating a mixture of equal volumes of the two gases.

Heat of Formation of Hydrobromate and Hydriodate of Hydrogen Phosphide.—J. Ogier.—Already noticed.

The Pyridic Bases.—A. Richard.—The bases which predominate in Dippel's oil are pyridin and lutidin; their joint proportion amounts to 40 per cent of the crude alkaloids. Picolin and collidin are present in smaller quantities. A small quantity of ethylic alcohol has also been obtained from the crude oil.

Partial Synthesis of Milk-Sugar and Contribution to the Synthesis of Cane-Sugar.—E. Demole.—Already noticed.

Products of the Transformation of Starch.—C. O'Sullivan.—With reference to the paper of MM. Musculus and Gruber (*Bulletin*, xxx., p. 54), the author remarks that they have doubtless overlooked his memoir in the *Journal of the Chemical Society* (ii., p. 125, 1876), in which he has shown that the molecular scission of starch takes place not according to one single equation, but to three equations, to which a fourth may be added:—

$$\underbrace{C_{72}H_{120}O_{60}}_{\text{Starch.}} + 3H_2O = \underbrace{3C_{12}H_{22}O_{11}}_{\text{Maltose.}} + \underbrace{C_{36}H_{60}O_{30}}_{\alpha\text{-Dextrine II.}}.$$

On Chlorophyll.—A. Gautier.—Already noticed.

Dingler's Polytechnisches Journal.

Band 234, Heft 4.

Production and Application of Phosphorescent Powders.—The patentees of this process (Prince Sagan, W. F. McCarty, and E. Peiffer) employ a mixture of 100 parts carbonate and phosphate of lime (obtained by the ignition of shells, especially *Tridama* and *Sepia*) with 100 parts quicklime, 25 parts of calcined salt, and 25 to 50 per cent of the whole mass of sulphur: 6 to 7 per cent of a colouring-matter—a sulphide of calcium, strontium, barium, magnesium, aluminium, &c.—must then be added. This powder serves to render barometers, compasses, &c., luminous, and is particularly phosphorescent under the influence of an electric current.

On the Leblanc Soda Process.—F. Fischer.—The author has examined the composition of the gases escaping from the black-ash furnaces, and the temperature of the melting mass. On one occasion only were dubious traces of carbonic oxide detected.

Acidimetry of Coloured Acids.—Dr. F. Salomon.—The author has devised an apparatus for the determination of crude wood-vinegar and other highly-coloured products. The process cannot be intelligibly described without the accompanying illustration.

Products of the Fats obtained by Acid Saponification on Distillation with Superheated Steam.—The fatty acids produced include the valerianic, capronic, œnanthylic, and caprylic.

Preparation of Red and Brown Naphthalin Dyes.—An abstract of the German Patent No. 5411, March 12, 1878.

Development of Dyeing, Printing, and Bleaching. Dr. A. Kielmeyer.—The continuation of a lengthy paper, not capable of useful abstraction.

On Methyl-anilin and Methylic Alcohol.—M. Bardy.—A summary of the methods for the production of these compounds, and for the detection of ethylic alcohol in admixture with the methylic.

Chemiker Zeitung.

No. 45, 1879.

Considerable sensation has been excited by the report that arsenic had been detected in the paper collars, &c., manufactured by a Leipzig firm. On a careful examination, conducted by six of the most eminent chemists, the accusation was proved to be utterly unfounded.

The explosion of a calendering machine at Gera, on November 21st, proved fatal to four persons.

MISCELLANEOUS.

The Science and Art Department.—From the Twenty-sixth Report of the Science and Art Department of the Committee of Council on Education, we learn that during 1878 there were 36 regular and 189 occasional students at the Royal School of Mines. At the Royal College of Chemistry there were 303 students, and at the Metallurgical Laboratory 74. The lectures delivered in the Lecture Theatre at South Kensington were attended by 5491 persons. The evening lectures to working men at the Royal School of Mines were attended by 1685 persons, being 458 more than in 1877; and 169 science teachers attended the special courses of lectures at the Science Schools, South Kensington. At the Royal College of Science for Ireland there were 22 associates or regular students, and 53 occasional students; while the various courses of lectures there were attended by 1421 persons.

MEETINGS FOR THE WEEK

Saturday, 13th.—Physical, 3. "A New Form of Resistance Balance for Comparing Standard Coils," J. A. Fleming, D.Sc. "The Graduation of Prof. Hughes' Sonometer," J. H. Poynting. "A Dispersion Photometer," W. E. Ayrton and J. Perry. "The Value of '*g*' at Tokio, Japan," W. E. Ayrton and J. Perry.
Monday, 15th.—Medical, 8.30
—— London Institution, 5.
—— Society of Arts, 8. (Cantor Lecture). "Chemistry of Bread and Bread Making," Dr Graham.
Tuesday, 16th.—Civil Engineers, 8.
—— Zoological 8.30.
Wednesday, 17th.—Society of Arts, 8. (Ordinary Meeting). "The Panama Canal," Captain Bedford Pim, R.N.
—— Geological, 8.
—— Meteorological, 7.
Thursday, 18th.—Royal, 8.30.
—— Chemical, 8. Ballot for the Election of Fellows. "On the Specific Volume and Density of Water of Crystallisation," T. E. Thorpe. "On the Analysis of Organic Bodies Containing Nitrogen &c.," W. H. Perkin.
—— Philosophical Club, 6.30.

COMPOSITION AND QUALITY OF THE METROPOLITAN WATER.

November, 1879.

The following are the returns of the Society of Medical Officers of Health:—

	Appearance in 2 foot Tube.	Ammonia.		Nitrogen as Nitrates, &c.	Oxygen used to Oxidise Organic Matter.	Total Solids.	Lime.	Magnesia	Chlorine	Sulphuric Anhydride.	Hardness on Clark's Scale	
		Saline.	Organic.								Before Boiling.	After Boiling.
		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Degrees	
Thames Water Companies.												
Grand Junction	Clear	0·000	0·009	0·180	0·050	21·10	7·630	0·576	1·152	1·400	14·3	3·7
West Middlesex	Clear	0·000	0·008	0·150	0·043	21·50	7·840	0·504	1·152	1·170	14·3	4·2
Southwark and Vauxhall	Clear	0·000	0·008	0·132	0·048	22·10	7·340	0·360	1·152	1·330	14·8	3·7
Chelsea	Slightly turbid	0·000	0·008	0·144	0·055	21·00	7·590	0·396	1·080	1·500	14·3	3·7
Lambeth	Clear	0·000	0·009	0·144	0·062	21·50	7·050	0·504	1·152	1·270	13·2	3·3
Other Companies.												
Kent	Clear	0·000	0·002	0·450	0·039	28·60	9·070	0·896	1·872	1·400	18·8	7·5
New River	Clear	0·000	0·007	0·138	0·014	20·60	7·630	0·432	1·152	1·730	14·8	3·3
East London	Clear	0·000	0·007	0·135	0·031	21·50	7·840	0·504	1·224	1·330	15·4	4·2

The quantities of the several constituents are stated in grains per imperial gallon.

Note.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

C. Meymott Tidy, M.B.

ROYAL INSTITUTION OF GREAT BRITAIN.

ALBEMARLE STREET, PICCADILLY, W.

LECTURE ARRANGEMENTS BEFORE EASTER, 1880.

Lecture Hour, Three o'clock.

CHRISTMAS LECTURES.

Professor TYNDALL, D.C.L., F.R.S.—Six Lectures on Air and Water; on December 27 (Saturday), 30, 1879; Jan. 1, 3, 6, 8, 1880. One Guinea the Course; Children under Sixteen, Half-a-Guinea.

Professor EDWARD A. SCHAFER, F.R.S.—Ten Lectures on The Physiology of Muscle; on Tuesdays, Jan. 13 to March 16. One Guinea.

H. HEATHCOTE STATHAM, Esq.—Two Lectures on Modern Architecture since the Renaissance; on Thursdays, Jan. 15 and 22. Half-a-Guinea.

Professor DEWAR, M.A., F.R.S.—Eight Lectures on Recent Chemical Progress; on Thursdays, Jan. 29 to March 18. One Guinea.

Professor T. RUPERT JONES, F.R.S.—Three Lectures on Coal; on Saturdays, Jan. 17, 24, 31. Half-a-Guinea.

Professor ERNST PAUER.—Three Lectures on Handel, Sebastian Bach, and Joseph Haydn. With Musical Illustrations. On Saturdays, Feb. 7, 14, 21. Half-a-Guinea.

Four Lectures on History of Literature, on Saturdays, Feb. 28, March 6, 13, 20. Half-a-Guinea.

Subscription (to Non-Members) to all the Courses during the Season, Two Guineas. Tickets issued daily.

Members may purchase not less than Three Single Lecture Tickets, available for any Lecture, for Half-a-Guinea.

The Friday Evening Meetings will begin on January 16th, at 8 p.m. Professor Dewar, F.R.S., will give a Discourse (Studies on the Electric Arc) at 9 p.m. Succeeding Discourses will probably be given by Dr. W. B. Carpenter, Professor J. Marshall, Dr. Huggins, Mr. W. H. Preece, Rev. H. R. Haweis, Mr. F. J. Bramwell, Mr. H. N. Moseley, Dr. C. William Siemens, Professors Tyndall and Huxley, Lord Reay, Mr. G. J. Romanes, M. Lecoq de Boisbaudran, Mr. H. Pollock, Professor Frankland, Mr. H. H. Statham, Mr. W. Spottiswoode, and Mr. Warren De la Rue. To these Meetings Members and their Friends only are admitted.

Persons desirous of becoming Members are requested to apply to the Secretary. When proposed, they are admitted to all the Lectures, to the Friday Evening Meetings, and to the Library and Reading Rooms; and their Families are admitted to the Lectures at a reduced charge. Payment—First Year, Ten Guineas; afterwards, Five Guineas a Year; or a composition of Sixty Guineas.

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THE CHEMICAL NEWS

VOL. XL. No. 1047.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 280.)

IN spite of the similarity of the corresponding compounds of Na, Cu, and Ag, the metals can be very easily distinguished one from another, which agrees with the fact that the volume of the metal alone is not the same as the volume of the metal when combined with another element. The volume of Na=24, of Cu=7, of Ag=10. The atoms of Na are further apart from each other and are more susceptible to reaction than the atoms of Cu and Ag. When Na enters into combination with another body, there is often a considerable contraction takes place. For example, the volume of Na=24, the volume of NaHo=19; 24 volumes of Na give 27 volumes of NaCl, whilst 10 volumes of Ag give 26 volumes of AgCl. This and many other examples show how arbitrary it is to conclude from the known volume of a compound the unknown volumes of its elementary parts.

We see, from the inspection of Table I.,* that the members at the beginning of the large periods (as well as the small periods commencing with Na and Li) are metals of a very strongly pronounced alkaline nature, whilst the members at the end are energetic haloids. Already, in the time of electro-chemists, the above-mentioned elements occupied the same positions of extreme members in the system. It is incontestable that the electro-chemical theory has had a great deal of influence on the later progress of chemistry. However, I am far from wishing to set myself up as a defender of this theory. To show this I will mention that, as can be seen in Table I., the first and last members of the *large periods* are the only ones which have a clearly defined chemical character. In other words, they are the only elements which react easily, and at temperatures which are not too high, with the greater number of other bodies; they alone possess atomic weights of about the same value, and some other analogous properties. The volume of a compound body increases nearly in equal quantities when H is replaced by Cl (=35·5), or by K (=39). When metaleptic hydrogen is replaced by chlorine the volume increases in a nearly constant ratio. For examples :—

Volume	$C_5H_{12}=110$	$C_6H_6=87$	$C_7H_8=104$
,,	$C_5H_{11}Cl=117$	$C_6H_5Cl=97$	$C_7H_7Cl=110$
Diff. of vol. when H is replaced by Cl	7	10	6

The volume increases in an analogous manner, and in nearly the same quantity, when H is replaced in the acids by K.

Volume	$HCl=29$	$H_2O=20$	$HNO_3=41$	$H_2SO_4=53$
,,	$KCl=37$	$KHO=28$	$KNO_3=48$	$K_2SO_4=66$
Diff. of vol. when H is replaced by K	8	8	7	13

We can bring together, according to their atomic weights, the following unlike elements :—

O = 16	F = 19	Na = 23	Mg = 24
S = 32	Cl = 35·5	K = 39	Ca = 40
Se = 78	Br = 80	Rb = 85	Sr = 87
Te = 125 ?	I = 127	Cs = 133	Ba = 137

The transition from Cl to K, &c., corresponds also, in many respects, to a certain analogy between these elements, although in the same period there are no elements having such similar atomic weights and such different properties. Because of this last fact, it might be better to separate the series here, in such a manner that the large periods commence with K and terminate with Cl. But in reality the series of elements is uninterrupted, and represents in a certain degree a spiral function.

In consequence of this, the most dissimilar elements are found at the beginning and at the end of large periods; in the middle are the transitory elements, and the most analogous are the nearest together. It is in this manner that after the elements of the alkalies and the alkaline earths come these rare elements (metals of gadolinite and cerite, Ti, V, Cr, Nb, Mo, Ta, W, Ur), which, even from an analytical point of view, are similar amongst themselves. They are not volatile; they are difficultly fusible, and difficult to reduce; they possess, even in their highest oxides, a feeble power of reaction; they are often found together in nature, and rarely in large quantities, &c. These elements are rare, and I even think that that is because of their character and not by chance. We can mention as a comparison that among the hydrocarbides the series C_nH_{2n+2} and C_nH_{2n-6} are often found together in nature, both being formed in many reactions; they possess a pronounced reaction and furnish many derivatives, while the members of the intermediate series, particularly C_nH_{2n} and C_nH_{2n-2} are formed more rarely, and do not give so many independent combinations as the preceding series. Our knowledge about the rare elements that I have just mentioned is unfortunately very defective, and if we had not before us the classic researches of Marignac on the compounds of Zr, Nb, and Ta, the entire group would be a collection of elements without any importance in the system. The works of Blomstrand, of Roscoe, of Delafontaine, and of Bunsen have thrown much light on the characters of the rare elements; but these elements are still the object of a series of questions which have not yet been answered.

After these rare elements (see Table I.) comes first in importance the group of elements called *noble*; in the system they all grouped together. The useful metals are attached to them, and by the help of As, Sb, and Te, they lead on to the metalloids.

In the groups of analogous elements, the elements whose atomic weights are the highest possess more strongly marked basic properties, or form weaker acids. Bunsen has shown that Cs is more electro-positive than K and Rb; the basic properties are more apparent in BaO than in CaO, in ThO_2 than in ZrO_2 or TiO_2; HgO separates MgO or BeO from compounds; Bi_2O_3 is a more energetic base than Sb_2O_3 or As_2O; P_2O_3 does not exhibit any basic properties, unless it is in this circumstance, that PH_3O_3 is not a tribasic acid, but a dibasic acid. For the same reason Ta gives a more feeble acid than Nb and V, Te an acid more feeble than Se and S. The acid properties are very feebly marked in PbO_2,* although Frémy obtained a salt, $K_2PbO_3,3H_2O$, corresponding to salts prepared by means of stannic and silicic acids; SnO_2 possesses feeble basic and acid properties; and SiO_2 cannot act except as an acid, although as a weak acid.

Besides this, when the atomic weight increases in the members of a determined group, it is not only that the faculty of being reduced to the state of a simple body increases (compare Te and Se with S, I with Cl, Au with Cu, &c.), but also the power of giving lower forms of oxidation, exhibits itself frequently by a relative stability and by a great aptitude for forming compounds. Bi forms Bi_2O_5 with difficulty—generally the compounds of bismuth correspond to Bi_2O_3, or BiX_3; in the same manner

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* See CHEMICAL NEWS, vol. xl, p. 268.

* A true analogue of SnO_2,PbO_2, should also be able to act as a base. However, the attempts that I have made, above all in that which concerns the action of HF, have led to no results. To all appearance the known form, PbO_2, answers to metastannic and metatitanic acid. We must wait for the discovery of a variety of PbO_2 with basic properties.

Pb does not only form PbO_2, but also the very stable oxide PbO, which Sn and Si are not capable of doing to the same degree; Tl does not only form Tl_2O_3 but also Tl_2O, which has not been observed either in the case of In or of Al.

In the group Mg, Zn, Cd, Hg, we notice, with the augmentation of the atomic weight, a marked increase in the volatility, basic properties of the oxide RO, reducibility to the metallic state, and the power of forming a lower oxide, R_2O.[*] The volatility does not increase with the augmentation of the atomic weight, except in this and the neighbouring series; on the contrary, it diminishes in the last series, as is well shown by Cl, Br, and I.

It is precisely for the motives expressed above that the so-called noble metals occupy the place which has been given to them in the system,—that is, in the middle of the large periods, amongst the members having high atomic weights, which comprises elements which are very easily reducible, and whose reactions are very weak.

All that has preceded shows the nature of the periodic law. No natural law acquires any scientific importance unless it introduces, so to speak, some practical conclusions, or, in other words, unless it admits of logical conclusions capable of explaining what has before remained unexplained, and, above all, unless it raises questions which can be confirmed by experience. In a case of this nature the use of the law is evident, and it is possible to control its correctness.

This law will at least incite research into the new, little-known parts of science. This is why I propose to study attentively some consequences of the periodic law, and to examine how it can be applied—

To the system of elements;
To the determination of the atomic weights of insufficiently studied elements;
To the determination of the properties of elements up to the present time unknown;
To the correction of atomic weights;
And to the enlargement of our knowledge of the forms of chemical combinations.

I shall not form any hypotheses, either here or further on, to explain the nature of the periodic law; for, first of all, the law itself is too simple;[†] and, secondly, this new subject has been too little studied yet, in its diverse parts, for us to be able to form any hypothesis: the most important reason is the third one,—that is, that we cannot put the periodic law and the atomic theory in accord without upsetting the known facts about the exact values of the most carefully found atomic weights. There is, however, I believe, between the series of elements and the homologous series, an analogy which, although small, is not less real, which authorises me to admit that it is so; it is the comparison of the physical properties of a group to which I shall return later on.

(To be continued.)

THE DISSOCIATION OF CHLORINE.

Victor Meyer's Answer to Seelheim's Critique.[‡]

Since I communicated to you Seelheim's experimental critique[§] of V. Meyer's famous experiments this investigator has published an answer to that critique, which (I rejoice to say) amounts to a complete and (I believe) unanswerable refutation.

What V. Meyer says is easily condensed in a few words. It is quite true that at a "yellow" heat platinum-metal can be volatilised in a current of chlorine. V. Meyer himself has often repeated Troost and Hautefeuille's experiments; but, in looking into the matter quantitatively, he found that at —1570° C. a given quantum of metallic platinum, when exposed to a rapid current of dry chlorine for a whole hour, lost only 1 per cent of its weight. In his vapour-density determinations the platinum produced (from the $PtCl_2$) is exposed to a stagnant atmosphere of chlorine for only a few seconds. It is difficult to assume that, under these circumstances, more than perhaps a few hundredths of a per cent of the metal could possibly get gasified. But, what is more, he always took care, after the experiment, to examine the wee bucket which served for the introduction of the platinous chloride, and he invariably found it full of spongy metal, the weight of which (whenever the test was applied) agreed almost absolutely with that calculated from the weight of the chloride used. Of crystalline or sublimed platinum no trace could be discovered.

Moreover, iodine, as V. Meyer stated in his first communication, behaves at high temperatures as chlorine does, although it naturally was used as such, and not in the shape of a platinum compound at all.

It appears, then, that V. Meyer after all is right, and that we must admit that the substance Cl_2 at high temperatures suffers decomposition, perhaps according to equation $2Cl_2 = Cl_2 + Cl + Cl$. This from the first was my theory of the phenomenon, and I mean to retain it until it is disproved. Not that I claim any credit for an idea which is so obvious that it must have suggested itself to any chemist who took the trouble of reasoning on the matter.

Lieben[*] (besides offering this very obvious explanation) suggests that possibly V. Meyer's result may be owing only to the fact that the coefficient of expansion of chlorine increases rapidly at high temperatures, and he does not see that he thereby only re-states the problem. In any gas of moderate tension the molecules must be assumed to be mere points compared with their average distances. If such a thing expands on being heated it can do so only through two causes, viz., first, an increase in the energy of the progressive motion of the molecules; and secondly, a multiplication of molecules, *i.e.*, through dissociation. The expansion owing to the first cause amounts to 1-273rd of the volume at 0° C. per degree Centigrade. To say that a certain gas, within a certain interval of temperature, expands at a greater rate is only another way of stating that the number of molecules in it increases in consequence of the respective elevation of temperature.

W. D.

Anderson's College, Glasgow

SEPARATION OF PHOSPHORIC ACID FROM THE SESQUIOXIDES OF IRON AND ALUMINA.

By M. P. DEROME.

The separation of phosphoric acid when combined with sesquioxides of iron and alumina is effected in a very satisfactory manner by the following method:—

The substance, mixed with from five to six times its weight of dry sodic sulphate, is strongly heated for eight or ten minutes over an enameler's blast-lamp; when cool the mass is extracted with water, which dissolves the excess of sodic sulphate and the phosphoric acid in the state of tribasic phosphate of soda.

The phosphoric acid in this liquid can be determined either by means of a standard solution of uranium, or by

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[*] It can be foreseen that cadmic oxide will give a basic suboxide, Cd_2O,—certainly very unstable in air,—or else salts CdX, which correspond to it.

[†] However, I do not ignore that to completely understand a subject we should possess, independently of observations (and experiences) and of laws (as well as systems), the meanings of both one and the other.

[‡] From an article in the *Ber. der Deutsch. Chem. Ges.*, No. 18. Communicated by Prof. Dittmar.

[§] Chemical News, vol. xl., p. 244.

[*] Extract from *Comptes Rendus* No. 6 in No. 18 of the *Berichte*.

precipitation of the phosphoric acid in the state of argentic phosphate or ammonio-magnesic phosphate.

This method may be applied to the treatment of phosphoric acid in soils, iron ores, and generally in every material containing small quantities of phosphoric acid and much iron and alumina.

In soils phosphoric acid compared with the sesquioxides is always found in feeble quantities. It suffices, then, after the elimination of the silica and of the residue insoluble in acids, to search for phosphoric acid in the precipitate of ferric oxide and aluminium, as obtained by the aid of heat from a solution almost neutral in presence of sodic acetate.

If a very calcareous soil does not contain sufficient sesquioxides for the total precipitation of phosphoric acid, a slight excess of ferric oxide may be added; the richness of the precipitate in phosphoric acid is a sure indication of the sesquioxides being in sufficient quantity.

Synthetical experiments have given amongst others the following results, which sufficiently show the value of the method:—

Fe_2O_3 Introduced.	Al_2O_3 Alumina Oxide.	Phosphoric Acid Introduced.	Phosphoric Acid Found.
0·308	0·108	0·025	0·0249
0·195	0·300	0·010	0·010
1·195	0·300	0·040	0·040
0·310	0·115	0·125	0·1247
0·110	0·300	0·125	0·125
0·310	0·115	0·005	0·005
0·110	0·300	0·005	0·005

—*Comptes Rendus*, December 1st.

FURTHER EXPERIMENTS ON THE VAPOUR DENSITIES OF POTASSIUM AND SODIUM.*

By Professor JAMES DEWAR, M.A., F.R.S., and ALEXANDER SCOTT, B.A.

In our former communication "On the Vapour Densities of Potassium and Sodium,"† we pointed out the chief obstacles which lay in the way of an exact determination of these constants. Having overcome the chief manipulative difficulties in connection with the method we described, there still remained the problem for solution as to how far the use of iron bottles in our experiments might affect the results. If the iron retained the metals or allowed their vapours to diffuse with rapidity through it, a considerable error might be produced without its being easily detected. We noted an action of this kind, remarking that "both metals seemed to have a tendency to behave in the same manner as zinc, viz., to form an alloy with the iron, because the vapour evolved after a few minutes was absorbed completely, in spite of all precautions to prevent oxidation." The tendency of iron and the alkali metals to form alloys, we thought, would be diminished, so as not to interfere with the value of the results, "by raising the temperature as much as possible, so as to induce rapid volatilisation," and the fair accordance of the series of experiments formerly given led us to suppose that this difficulty had been successfully obviated. Recent spectroscopic observations, by Professors Liveing and Dewar, on the luminous absorption of the vapours of sodium under different conditions in iron and platinum vessels—which will be presented to the Society—having led to the inference that mere rapidity of volatilisation, of such small weights of the metals as can be conveniently employed for the measurement of the volumes of the vapours, in presence of a relatively enormous mass of iron, would not eliminate the absorptive action, new experiments were made in a platinum apparatus of similar shape and size to the iron one, and in the same manner as formerly described. Magnesia was used instead of sand to pack the platinum vessel in the crucibles, employed as a protection against the diffusion of furnace gases, and the volatilisation of the alkali metals took place in nitrogen. Each set of experiments was made at different times, and the results are given in the order of observation, the bottle being freed from the vapours after each experiment by a strong current of hydrogen. The molecular weights are calculated for 22·34 c.c. at 0° C. and 760 m.m. pressure.

The following tables contain the record of the results obtained:—

Potassium.

I.

0·046	grm. gave	24·1	c.c. at 0°	and 760 m.m.	Mol. wt.	42·6
0·045	„	23·1	„	„	„	43·5
0·042	„	21·2	„	„	„	44·2
0·045	„	22·9	„	„	„	43·9
0·045	„	22·1	„	„	„	45·5
0·030	„	25·1	„	„	„	44·5
					Mean molecular weight	44·03

II.

0·047	grm. gave	26·8	c.c. at 0°	and 760 m.m.	Mol. wt.	39·2
0·049	„	26·0	„	„	„	42·1
					Mean molecular weight	40·65

Sodium.

I.

0·032	grm. gave	26·5	c.c. at 0°	and 760 m.m.	Mol. wt.	27·0
0·033	„	26·7	„	„	„	27·6
0·031	„	27·9	„	„	„	24·8
					Mean molecular weight	26·4

II

0·032	grm. gave	25·1	c.c. at 0°	and 760 m.m.	Mol. wt.	28·5
0·032	„	26·3	„	„	„	27·2
0·031	„	27·9	„	„	„	24·8
0·029	„	26·5	„	„	„	24·4
0·031	„	26·9	„	„	„	25·7
0·030	„	27·3	„	„	„	24·6
0·030	„	26·1	„	„	„	25·6
					Mean molecular weight	25·8

III.

0·027	grm. gave	24·6	c.c. at 0°	and 760 m.m.	Mol. wt.	24·5
0·027	„	23·2	„	„	„	26·0
0·037	„	31·7	„	„	„	26·1
0·030	„	29·1	„	„	„	23·0
					Mean molecular weight	24·9

The new determinations of the molecular weights of potassium and sodium are just about half the former values, and would seem to support the inference that the atom of each of these metals resembles mercury and cadmium in the gaseous state, as regards molecular volume. Such a remarkable result cannot be accepted without a very thorough investigation of the secondary reactions when any take place, under the conditions of the experiment. It is certain that in the platinum vessels there is much less absorption of the vapour than in the case of iron, and that the action of the furnace gases is all but eliminated. The following suggestion towards an explanation of the results naturally occur. The metals may contain a large amount of occluded hydrogen. With reference to this assumption, we have examined the sodium used in our experiments and find, on careful exhaustion and boiling in a Sprengel vacuum, that one volume of sodium contains only one-third of its volume of occluded hydrogen, so that this will not account "for the double volume of the atom of

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* Abstract of Paper read before the Royal Society.

† *Proc. Roy. Soc.*, January, 1879.

the metals." The alkali metals may form volatile compounds with platinum, although, judging from analogy, such compounds are not likely to exist. If so, the vapour blown out of the bottle ought to contain platinum. The use of platinum tubes to blow out the vapours prevented the test being applied. Occluded oxygen from the platina might transform the metals into oxides, and thus complicate the results. We have, however, always observed plenty of free metallic vapour on blowing out the bottle, so that the metals remain chiefly in the state of vapour. Unless some other explanation can be given, it will be necessary to admit some anomaly in the behaviour of potassium and sodium, as regards their vapour densities at high temperatures. In future the variation of the density with the temperature must be determined, but this is very difficult at temperatures about 1500° C. The chief drawback to the prosecution of the experiments is the terrible waste of platinum vessels, which never stand the combined action of potassium, sodium, and hydrogen at high temperatures beyond two or three operations.

The following determinations of the molecular weight of potassium iodide, made in the iron apparatus, are of importance in connection with the previous results.

Potassium Iodide.

0·159	grm. gave	20·75	at 0°	and 760 m.m.	Mol. wt.	171·0
0·165	,,	21·2	,,	,,	,,	174·0
0·170	,,	21·4	,,	,,	,,	177·0
0·180	,,	21·6	,,	,,	,,	186·0
0·103	,,	15·1	,,	,,	,,	152·0
0·174	,,	24·4	,,	,,	,,	159·0
					Mean molecular weight	169·8

These numbers are fairly accordant, and seem to indicate that iodide of potassium is normal in its behaviour. The vapour after each experiment was blown out with a current of hydrogen. A crystalline deposit was obtained in each case, which was pure iodide of potassium, free from any trace of iron. Taken in connection with the former experiments, this seems to show that, if free potassium is abnormal, its compounds are not altered. Before any final conclusions can be reached, further experiments must be made in platinum or iridium vessels, and it will be very important to control the results by examining the densities of the iodides of cæsium and rubidium.

ON THE VAPOUR-DENSITIES OF PEROXIDE OF NITROGEN, FORMIC ACID, ACETIC ACID, AND PERCHLORIDE OF PHOSPHORUS.

By J. WILLARD GIBBS.

(Concluded from p. 285.)

In Table VI. are exhibited the results of experiments by Playfair and Wanklyn,[*] in which the vapour of the acid was diluted with hydrogen or, in a single case (the experiment at 95·5°), by air. Columns I. and II. of the observed densities relate each to a series of observations by the method of Gay-Lussac; column III. contains four independent determinations by the method of Dumas. The numbers in the column of pressures are, as in other similar cases, the partial pressures obtained by subtracting from the total pressure (which was never very much less than that of the atmosphere) that which would be exerted by the hydrogen or air alone.

The first observation of the first series gives the density 1·936, which is doubtless too small, since it is much less than the theoretical limit 2·073. Since the greater part of the measurements from which this number was calculated were also used in reducing the other observations of the series the error probably affects the other observations and in a somewhat increased degree. This will account only for a part of the difference between the observations and the formula. The remaining part of the differences in this series, and the somewhat smaller differences in the next, may be due to the fact that the experiments of both series were conducted with descending temperatures. Yet the experiments of the third column, which were made by Dumas's method, do not exhibit any preponderance of positive values for the excess of observed density, but rather the opposite.

On the whole, these experiments furnish no decisive indication of any influence of the hydrogen or air upon the vapour. They may be thought to corroborate slightly the tendency observed in the experiments of Naumann and Troost toward lower densities than the formula gives at very low pressures. Yet where the experiments of Naumann show the greatest deficiency in observed density (at 78° and 80 m.m.), an experiment of Playfair and Wanklyn, at almost the same temperature and pressure, gives a trifling excess of observed density, and at a little lower temperature and pressure, where we should expect from the experiments of Naumann that the deficiency would be still greater, an experiment of Playfair and Wanklyn shows a great excess of density.

By combining the experiments of Cahours, Naumann and Troost, we may obtain observations of density at 130° for a very wide range of pressures. For one atmosphere, we may regard the formula as coinciding with the average of the numbers given by Cahours. For pressures between three-quarters and one-half of an atmosphere the experiments of Naumann show an excess of density; at pressures below half an atmosphere the experiments both of Naumann and of Troost show a deficiency of density as compared with the formula. For an indefinite diminution of pressure there can be little doubt that the real density, like the value given by the formula, approaches the theoretical value 2·073. The greatest excess in the numbers obtained by experiment is 0·07; the greatest deficiency is 0·19, which occurs at 59·7 m.m. The next in order of magnitude is 0·11. which occurs more than once. These discrepancies are certainly such as may be accounted for by errors of observation. They do not appear to be greater than we might expect on the hypothesis of the entire correctness of the formula. On the other hand, the agreement is greater than we should expect, if we reject the theory on which the formula was obtained. It is about such as we might expect in a suitable formula of interpolation with three constants, which have been determined by the values of the density for one atmosphere, for half an atmosphere, and for infinitesimal pressures. But we must regard the actual formula, in its application to this single temperature, as having only two constants, of which one is determined so as to make the formula give the theoretical value for infinitesimal pressures, and the other so as to make it agree with the experiments of Cahours at the pressure of one atmosphere.

An entirely different method has been employed by Horstmann[*] to determine the vapour-density of this substance. A current of dry air is forced through the liquid acid, which is heated to promote evaporation, and the mixture of air and vapour is cooled to any desired temperature, with deposition of the excess of acid, by passing upward through a spiral tube in a suitable bath. The acid is then separated from the air, and the quantity of each determined. It is assumed that the air is exactly saturated with vapour on leaving the coil, and that it has the temperature of the bath. If we know the pressure of saturated vapour for that temperature, and assume the validity of Dalton's law, it is easy to calculate the density of the vapour. For the pressure of the air is found by subtracting the pressure of the vapour from the total pressure (the experiments were so conducted that this was the same as

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[*] *Trans. Roy. Soc. Edin.*, vol. xxii., p. 455.

[*] *Berichte der Deutschen Chemischen Gesellschaft*, Jahrg. iii. (1870), s. 78; and Jahrg. xi (1878), s. 1287.

TABLE VI.—ACETIC ACID.

Experiments of Playfair and Wanklyn.

Temperature.	Pressure.	Density calc. by eq. (12).	Density observed. I.	Density observed. II.	Density observed. III.	Excess of observed Density. I.	Excess of observed Density. II.	Excess of observed Density. III.
212·5	322·8	2·124		2·060			−·064	
194	326·0	2·168		2·055			−·113	
186	254·4	2·173	1·936			−·237		
182	319·4	2·213		2·108			−·105	
166·5	289·5	2·293		2·350			+·057	
163	245·8	2·290	2 017			−·273		
132	227·5	2·628	2·292			−·336		
130·5	285·7	2·729		2·426			−·303	
119	269·0	2·914		2·623			−·291	
116·5	211·3	2·876	2·371			−·505		
95·5	(123·8)	3·105			2·594			−·511
86·5	(200·4)	3·432			3·172			−·260
79·9	(83·3)	3·297			3·340			+·043
62·5	(46·2)	3 473			3·950			+·477

the actual pressure of the atmosphere), and the ratio of the weights of the acid and the air obtained by analysis, divided by the ratio of their pressures, will give the ratio of their densities. The pressures of saturated vapour employed by Horstmann are those given by Landolt,[*] and differ greatly from the determinations of Regnault, in some cases being nearly twice as great,—a difference noticed but not explained by Landolt, who, however, gives determinations (previously unpublished) of Wüllner, which somewhat exceed his own. (On the other hand, the observations of Bineau substantially agree with those of Regnault.)

If we compare the observations of Horstmann with the values given by equation (12) on the basis of Landolt's pressures we find a very marked disagreement, as may be seen by the following numbers, which relate to the highest temperatures of Horstmann's experiments, where the disagreement is least:—

Temperature—	63·1	62·9	59·9	51·1	49·0	48·7	44·6	41·4
Pressure (Landolt)—	110·0	109·2	97·0	69·0	63·4	63·0	53·1	46·6
Density calculated by eq. (12)—	3·67	3·67	3·69	3·75	3 77	3·77	3·79	3·81
Density observed—	3·19	3·11	3·12	3·16	2·89	2 98	2·75	2 62

It will be observed that while the values obtained from equation (12) increase with diminishing temperatures the values obtained from Horstmann's experiments diminish. This diminution continues as far as the experiments go, until finally at 12° or 15° the densities are only one-half as great as those obtained by Bineau, by direct experiment at the same temperatures and at somewhat less pressures, in a series of observations which bear every mark of a very exceptional precision. (Compare Tables VII. and IV.) The explanation of this disagreement is doubtless to be found in the values of the pressures employed in the calculations, and it will be interesting to see how the results may be modified by the adoption of different pressures.

In determinations of the pressure of saturated vapours too great values are so much more easily accounted for than errors in the opposite direction, especially when the pressures are small, that especial interest attaches to the lowest figures which are supported by a competent authority. The experiments of Regnault[†] were made with three different preparations of acetic acid, of which the second was once, and the third twice, purified by distillation over anhydrous phosphoric acid. Each distillation considerably diminished the pressure of the saturated vapour, the effect of the second distillation being about half that of the first. The numbers obtained with the third preparation are given in the following table, with their logarithms and the differences of the logarithms for one degree of temperature:—

Temperature.	Pressure.	Log. Pressure.	Diff. per 1°.
9·71	6·42	0·8075	0·0239
12·12	7·33	0·8651	0·0272
14·33	8·42	0·9253	0·0161
14·87	8·59	0·9340	0·0252
17 23	9 85	0·9934	0·0251
19 84	11·455	1·0590	0·0237
22·37	13·15	1·1189	0·0232
25·28	15·36	1·1864	

The uniformity of the numbers in the last column shows the remarkable precision of the determinations. At the same time it is evident that the differences in these numbers are due principally to the errors of observation, so that numbers obtained by interpolation between the logarithms of the observed pressures will be somewhat better (on account of averaging of the errors) than the original determinations.

The values obtained by such an interpolation have been used for the comparison of Horstmann's experiments with the formula (12) which is given in Table VII. Unfortunately, this comparison cannot be extended above 25°, which is the limit of Regnault's experiments. The first three columns of the table give the temperatures of Horstmann's experiments, the pressures corresponding to these temperatures according to the determinations of Landolt, and the density deduced from Horstmann's experiments by the use of these pressures. To these columns, which are taken from Horstmann's paper, are added the pressure derived from Regnault's observations by the logarithmic interpolation described above, the density calculated by equation (12) from these pressures and the temperatures of the first column, and the densities obtained by combining Horstmann's experiments with Regnault's pressures. This column is derived from the second, third, and fourth, as follows. If w and W denote respectively the weights of vapour and of air which pass through the apparatus in the same time, P the height of the barometer, and p_L the pressure of saturated vapour as determined by Landolt, the densities obtained on the basis of Landolt's pressures, and given in the third column, are evidently represented by—

$$\frac{w(P-p_L)}{Wp}$$

The numbers of the fifth column, which are represented in the same way by—

$$\frac{w(P-p_R)}{Wp_R},$$

where p_R denotes the pressure as determined by Regnault's

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[*] *Liebig's Annalen*, suppl. vi. (1868), p. 157.

[†] *Mem. Acad. Sciences.*, vol. xxvi., p. 758. The experiments date from 1844.

experiments, have been calculated by the present writer by multiplying the numbers of the third column by—

$$\frac{p_L(P-p_R)}{p_R(P-p_L)}$$

Table VII.—Acetic Acid.

Determinations of Vapour-density by Distillation.

Temp.	Pressure according to Landolt.	Density observed, Horstmann & Landolt.	Pressure according to Regnault.	Density calc. from Regnault's presssures by eq (12).	Density observed, Horstmann & Regnault.	Excess of observed density.	
						I.	II.
25·0	23·5	2·42	15·13	3·86	3·80	−·06	
23·8	22·4	2·23	14·19	3·86	3·56		−·30
22·6	21·6	2·29	13·31	3·87	3 76	−·11	
21·5	20·4	2·24	12·54	3·87	3·68	−·19	
20·4	19·2	2·05	11·81	3·88	3·37		−·51
20·2	19·0	2·28	11·68	3·88	3·75	−·13	
20·0	18·9	2·13	11·56	3·88	3·52		−·36
17·4	16·8	2·09	9·95	3·89	3·56	−·33	
15·6	15·6	1·98	8·96	3·90	3·48	−·42	
15·3	15·3	1·95	8·81	3·90	3·42		−·48
15·3	15·3	1·85	8·81	3·90	3·24		−·66
14·7	15·1	1 78	8·54	3·91	3·18	−·73	
12·7	13·7	1·96	7·60	3·91	3·56	−·35	
12·4	13·5	1·89	7·46	3·92	3·45	−·47	

As the height of the barometer in Horstmann's experiments is not given it has been necessary to assume P=760. The inaccuracy due to this circumstance is evidently trifling. The last two columns of the table, which relate to different series of experiments by Horstmann (a distinction not observed in other parts of the table), give the excess of the densities thus obtained from Horstmann's and Regnault's experiments above the values calculated from equation (12) with the use of Regnault's determinations of pressure.

The densities obtained by experiment are without exception less than those obtained from equation (12). At the highest temperatures, where the liability to error is the least, both in respect to the measurement of the pressure of saturated vapour and in respect to the analysis of the product of distillation, the results of experiment are most uniform, and most nearly approach the numbers required by the formula. At the lowest temperatures the greatest observed density is about one-eleventh less than that required by the formula, the difference being about the same as between the highest and lowest observed values for the same temperature.

Since each successive purification of the substance employed by Regnault diminished the pressure of its vapour, it is not improbable that the pressures might have been still farther diminished by farther purification of the substance. The pressures which we have used are therefore liable to the suspicion of being too high, and it is quite possible that more accurate values of the pressure would still farther reduce the deficiency of observed density.

Perchloride of Phosphorus.—For this substance we have at atmospheric pressure a single determination of vapour-density by Mitscherlich,[*] and a series of determinations by Cahours;[†] at lower pressures we have determinations by Wurtz[‡] and by Troost and Hautefeuille.[§] In the experiments of Wurtz the pressure was reduced by mixing the vapour with air. In Table VIII. all these determinations are compared with the formula—

$$\log\frac{3\cdot6(D-3\cdot6)}{(7\cdot2-D)^2}=\frac{5441}{t_c+273}+\log p-14\cdot353. \qquad (13)$$

The differences between the calculated and observed values are often large, in six cases exceeding 0·30; but they exhibit in general that irregularity which is characteristic of errors of observation. We should expect large errors in the observed densities on account of the difficulty of obtaining the substance in a state of purity, and because the large value of the density renders it very sensitive to the effect of impurities which diminish the density,—also because the specific heat of the vapour is great, as shown by the numerator of the fraction in the second member of (13),[*] and because the density varies very rapidly with the temperature as seen by the numbers in the third column of Table VIII.

Table VIII.—Perchloride of Phosphorus.

Experiments of Mitscherlich, Cahours, Wurtz, and Troost and Hautefeuille.

Temperature.	Pressure.	Density calc. by eq. (13).	Density observed.		Excess of observed density.	
			Mitsch.	Cahours.	Mitsch.	Cahours.
336	(760)	3·610		3·656		+·046
327	754	3·614		3·656		+·042
300	765	3·637		3·654		+·017
289	(760)	3·656		3·69		+·034
288	763	3·659		3·67		+·011
274	755	3·701		3·84		+·139
250	751	3·862		3·991		+·129
230	746	4·159		4·302		+·142
222	753	4·344	4·85		+·506	
208	(760)	4·752		4·73		−·021
200	758	5·018		4·851		−·167
190	758	5·368		4·987		−·381
182	757	5·646		5·078		−·568
			Wurtz.	T. & H.	Wurtz.	T. & H.
178·5	227·2	5·053		5·150		+·097
175·8	253·7	5·223		5 235		+·012
167·6	221·8	5·456		5·415		−·041
154·7	221	5·926		5·619		−·307
150·1	225	6 086		5·886		−·200
148·6	244	6·169		5·964		−·205
145	391	6·45	6·55		+·10	
145	311	6·37	6·70		+·33	
145	307	6 36	6·33		−·03	
144·7	247	6·287		6·14		−·147
137	281	6·53	6·48		−·05	
137	269	6 51	6·54		+·03	
137	243	6·48	6·46		−·02	
137	234	6 47	6·42		−·05	
137	148	6·31	6·47		+·16	
129	191	6·59	6·18		−·41	
129	170	6 56	6·63		+·07	
129	165	6·55	6·31		−·24	

But at the two lowest temperatures of Cahours's experiments the differences of the observed and calculated densities (0·381 and 0·568) are not only great, but exhibit, in connection with the adjacent numbers, a regularity which suggests a very different law from that of the formula. In fact, the densities obtained by Cahours at atmospheric pressure and those obtained by Troost and Hautefeuille at pressures a little less than one-third of an atmosphere seem to form a continuous series, notwithstanding the abrupt change of pressure. Yet it is difficult to admit that the density is independent of the pressure. So radical a difference between the behaviour of this substance and that of the others which we have been considering requires unequivocal evidence. Now it is worthy of notice that the experiment at 183°, in which the greatest discrepancy is seen, is not given in the first record of the experiments, which was in the *Comptes Rendus* in 1845. It is given in the *Annales de Chimie et de Physique* in 1847, where it is called the first experiment. (The experiment at 336° is also omitted in the *Comptes Rendus*, and that at 208° in the *Annales*; otherwise the lists are the same.) If it was the first experiment in point of time, which is apparently the meaning, it was made before the publication in the *Comptes*

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[*] *Pogg. Ann.*, vol. xxix. (1833), p. 221.

[†] *Comptes Rendus*, xxi. (1845), p. 625; and *Ann. de Chim. et de Phys.*, s. 3, vol. xx. (1847), p. 369.

[‡] *Comptes Rendus*, vol. lxxvi. (1873), p. 601.

[§] *Ibid.*, vol lxxxiii. (1876), p 977.

[*] Compare *Trans. Conn. Acad.*, vol. iii., p. 243.

Rendus, and we can only account for its omission by supposing that it was a preliminary experiment, in which its distinguished author did not feel sufficient confidence to include it at first with his other determinations, although he afterwards concluded to insert it. If we reject this observation as doubtful, the disagreement between the formula and observation appears to be within the limits of possible error, but additional experiments will be necessary to confirm the formula.*

Experiments have also been made by M. Wurtz, in which the vapour of the perchloride of phosphorus was diluted with that of the perchloride.† These experiments may be used to test equation (8), which, when the values of its constants are determined by equation (13), reduces to the form—

$$\log \frac{p_5}{p_2 p_3} = \frac{5441}{t_c + 273} - 13{\cdot}751, \qquad (14)$$

where p_5, p_2, and p_3 denote the partial pressures due respectively to the PCl_5, the Cl_2, and the PCl_3 existing as such in the gas-mixture. Since these quantities cannot be the subjects of immediate observation, a farther transformation of the equation would be convenient. Let M_3, M_2 denote the quantities of the protochloride and of chlorine of which the mixture may be formed, and P_3, P_2 the pressure which would belong to each of these if existing by itself with the same volume and temperature. These quantities will be connected with the eqnations—

$$P_2 = \frac{k\,t\,M_2}{2{\cdot}22\,v}, \qquad P_3 = \frac{k\,t\,M_3}{4{\cdot}98\,v}, \qquad (15)$$

where k denotes the same constant as before referred to. From the evident relations—

$$P_2 = p_2 + p_5, \quad P_3 = p_3 + p_5, \quad p = p_2 + p_3 + p_5,$$

we obtain—

$$p_5 = P_2 + P_3 - p, \quad p_2 = p - P_3, \quad p_3 = p - P_2;$$

and by substitution of these values in equation (14),—

$$\log \frac{P_2 + P_3 - p}{(p - P_2)\,(p - P_3)} = \frac{5441}{t_3 + 273} - 13{\cdot}751 \qquad (16)$$

In view of the relations (15) this may be regarded as an equation between the pressure, the temperature, the volume, and the quantities of protochloride of phosphorus and chlorine into which the gas-mixture is resolvable.

It is in this form that we shall apply the equation to the experiments of M. Wurtz, the results of which are exhibited in Table IX. The first column gives the number distinguishing each experiment in the original memoir; the second, the temperature; the third, the observed pressure (p) of the mixture of PCl_5, PCl_3, and Cl_2, which is the barometric pressure corrected for the small quantity of air remaining in the flask; the fourth, the pressure π due to the *possible perchloride*, found by subtracting the pressure due to the excess of protochloride (this pressure is calculated from the theoretical density of the protochloride) from the total pressure; the fifth, the density δ of the possible perchloride calculated from its pressure π with the temperature and volume. The numbers of these five columns are taken from the memoir cited, except that the correction of the barometric pressures has been applied by the present writer in accordance with the data furnished in that memoir. The two next columns contain the values of P_2 and P_3. These would naturally be calculated from M_2 and M_3 by equations (15). But since the values of M_2 and M_3 have not been given explicitly, those of P_2 and P_3 have been calculated from the recorded values of π and δ. Since the weight of the *possible chloride* is—

$$\frac{7{\cdot}2}{2{\cdot}22} M_2,$$

we have—

$$\delta = \frac{7{\cdot}2\, M_2\, k\, t}{2{\cdot}22\, v\pi} = \frac{7{\cdot}2}{\pi} P_3$$

Moreover,—

$$p - \pi = P_3 - P_2,$$

since both members of the equation express the pressure due to the excess of the protochloride. The values of P_2 and P_3 were obtained by these equations.

No. of expt.	t_c.	p (obs.)	π.	δ.	P_2.	P_3.	p calc. by eq. (16).	Excess of obs. value of p.
XII.	173·29	756·1	423	6·68	392·4	725·5	760·7	− 4·6
X.	165·4	748·4	413	6·80	390·1	725·5	747·9	+ 0·5
VII.	176·24	751·0	411	6·88	392·7	732·7	773·1	−22·1
VIII	169·35	724·1	394	7·16	391·8	721·9	750·5	−26·4
V.	175·26	743·3	343	7·03	334·9	735·2	764·4	−21·1
II.	164·9	758·5	338	7·38	346·4	766·9	782·9	−24·4
XI.	175·75	760·0	318	7·00	309·2	751·2	776·8	−16·8
IV.	175·26	756·3	271	7·06	365·7	751·0	770·9	−14·6
IX.	160·47	753·5	214	7·44	221·1	760·6	766·8	−13·3
I.	165·4	760·0	194	7·25	195·3	761·3	768·5	− 8·5
VI.	170·34	751·2	174	8·30	200·6	777·8	787·6	−36·4
III.	174·28	742·7	168	7·74	180·6	755·3	766·5	−23·8

The eighth column of the table gives the values of p calculated from the preceding values of t_c, P_2, and P_3, by equation (16); and the last column the difference of the observed and calculated values of p. The average difference is 18 m.m., or a little more than 2 per cent, the observed pressure being almost uniformly less than the calculated value. This deficiency of pressure is doubtless to be accounted for by a fact which MM. Troost and Hautefeuille have noticed in this connection. The protochloride of phosphorus deviates quite appreciably from the laws of Mariotte, Gay-Lussac, and Avogadro, the product of the volume and pressure of a given quantity of vapour at 180° and the pressure of one atmosphere being 1·548 per cent less than at the same temperature and the pressure of one-half an atmosphere.* Now we may assume, as a general rule, that when the product of volume and pressure of a gas is slightly less than the theoretical number (calculated by the laws of Mariotte, Gay-Lussac, and Avogadro) the difference for any same temperature is nearly proportional to the pressure.† It is therefore probable that between 160° and 180°, at pressures of about one atmosphere, the product of volume and pressure for protochloride of phosphorus is somewhat more than 3 per cent less than the theoretical number. The experiments of Wurtz, as exhibited in Table IX., show that the pressure, and therefore the product of volume and pressure (we may evidently give the volume any constant value as unity), in a mixture consisting principally of the protochloride, is on the average a little more than 2 per cent less than is demanded by theory, the differences being greater when the proportion of the protochloride is greater. The deviation from the calculated values is therefore in the same direction, and about such in quantity, as we should expect.‡

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* Additional experiments on the density of this vapour have been made by M. Cahours, concerning which he says in 1866: "Les déterminations qui je viens d'effectuer à 170 et 172 degrés (ce corps bout vers 160 à 165 degrés) m'ont donné des nombres qui, bien que notablement plus forts que ceux que j'ai obtenus antérieurement à 182 et 185 degrés sont encore bien éloignés de celui que correspond à 4 volumes." (*Comptes Rendus*, t. 63, p. 16.) So far as the present writer has been able to ascertain, these determinations have not been published. The formula gives 6·025 for 170° and 5·973 for 172°, at atmospheric pressure. The number corresponding to four volumes is 7·20.

† *Comptes Rendus*, vol. lxxvi. (1873), p. 601.

* Troost and Hautefeuille, *Comptes Rendus*, vol. lxxxiii. (1876), p. 334.

† Andrews, "On the Gaseous State of Matter." *Phil. Trans.*, vol. clxvi. (1876), p. 447.

‡ The deviation of the protochloride of phosphorus from the laws of ideal gases shows the impossibility of any *very close* agreement between such equations as have been deduced in this paper and the results of experiment in the case of gas-mixtures in which this substance is one of the components. With respect to the question whether future experiments on the vapour of the perchloride alone, or with an excess of chlorine or of the protochloride) will reduce the disagreement between the calculated and observed values to such magnitudes as occur in the case of the protochloride alone, it would be rash to attempt to anticipate the result of experiment.

M. Wurtz has remarked that the average value of δ (the density of the *possible perchloride*) is nearly identical with the theoretical density of the perchloride, and appears inclined to attribute the variations from this value to the errors of experiment. Yet it appears very distinctly in Table IX., in which the experiments are arranged according to the value of π (the pressure due to the *possible perchloride*), that δ increases as π diminishes. The experiments of MM. Troost and Hautefeuille show that the coincidence remarked by M. Wurtz is due to the fact that on the average in these experiments the deficiency of the density of the possible perchloride (compared with the theoretical value) is counterbalanced by the excess of density of the protochloride. When $\pi > 400$, the effect of the deficiency in the density of the possible pechloride distinctly preponderates; when $\pi < 250$, the effect of the excess of density in the protochloride distinctly preponderates. But the magnitude of the differences concerned is not such as to invalidate the general conclusion established by the experiments of M. Wurtz, that the dissociation of the perchloride may be prevented (at least approximately) hy mixing it with a large quantity of the protochloride.

TABLE X.

For the solution of the equation: $\log \frac{1000\,(\Delta - 1)}{(2-\Delta)^2} = L.$

L	Δ	Diff.	L	Δ	Diff.
0·7	1·005		4·2	1·778	
0·8	1·006	1	4·3	1·800	22
0·9	1·008	2	4·4	1·819	19
1·0	1·010	2	4·5	1·837	18
1·1	1·012	2	4·6	1·854	17
1·2	1·015	3	4·7	1·868	14
1·3	1·019	4	4·8	1·882	14
1·4	1·024	5	4·9	1·894	12
1·5	1·030	6	5·0	1·905	11
1·6	1·037	7	5·1	1·915	10
1·7	1·046	9	5·2	1·924	9
1·8	1·056	10	5·3	1·932	8
1·9	1·069	13	5·4	1·939	7
2·0	1·084	15	5·5	1·945	6
2·1	1·102	18	5·6	1·951	6
2·2	1·122	20	5·7	1·956	5
2·3	1·146	24	5·8	1·961	5
2·4	1·172	26	5·9	1·965	4
2·5	1·202	30	6·0	1·969	4
2·6	1·234	32	6·1	1·972	3
2·7	1·268	34	6·2	1·975	3
2·8	1·305	37	6·3	1·978	3
2·9	1·343	38	6·4	1·980	2
3·0	1·382	39	6·5	1·982	2
3·1	1·421	39	6·6	1·984	2
3·2	1·461	40	6·7	1·986	2
3·3	1·500	39	6·8	1·987	1
3·4	1·537	37	6·9	1·989	2
3·5	1·574	37	7·0	1·990	1
3·6	1·609	35	7·2	1·992	
3·7	1·642	33	7·4	1·994	
3·8	1·673	31	7·6	1·995	
3·9	1·703	30	7·8	1·996	
4·0	1·730	27	8·0	1·997	
4·1	1·755	25	9·0	1·999	
4·2	1·778	23			

Table for facilitating calculation.—The numerical solution of equations (10), (11), (12), and (13), for given values of t and p, may be facilitated by the use of a table, If we set—

$$\Delta = \frac{D}{D_1}, \qquad (17)$$

$$L = \log \frac{1000\, D_1\, (D - D_1)}{(2D_1 - D)^2} = \log \frac{1000\,(\Delta - 1)}{(2-\Delta)^2}, \qquad (18)$$

we have for peroxide of nitrogen,—

$$L = \frac{3118{\cdot}6}{t_c + 273} + \log p - 9{\cdot}451\,; \qquad (19)$$

for formic acid,—

$$L = \frac{3800}{t_c + 273} + \log p - 9{\cdot}641\,; \qquad (20)$$

for acetic acid,—

$$L = \frac{3520}{t_c + 273} + \log p - 8{\cdot}349\,; \qquad (21)$$

and for perchloride of phosphorus,—

$$L = \frac{5441}{t_c + 273} + \log p - 11{\cdot}353. \qquad (22)$$

By these equations the values of L are easily calculated. The values of Δ may then be obtained by inspection (with interpolation when necessary) of the following table. From Δ the value of D may be obtained by multiplying by D_1, viz., by 1·589 for peroxide of nitrogen or formic acid, by 2·073 for acetic acid, and by 3·6 for perchloride of phosphorus.*

The constants of these equations are of course subject to corrections by future experiments, which must also decide the more general question—in what cases, and within what limits, and with what degree of approximation, the actual relations can be expressed by equations of such form. In the case of perchloride of phosphorus especially the formula proposed requires confirmation.—*American Journal of Science and Arts.*

PROCEEDINGS OF SOCIETIES

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

Mr. JAMES MACTEAR, President, in the Chair.

AT the Annual Business Meeting of this Society on November 24, a short paper was read by Mr. J. B. HANNAY on "*Crystalline Cavities*," in which he brought forward some theories as to the possible formation of crystals.

The President's Address was read at the next meeting, December 8, an abstract of which is given below.

"*On the Antiquity of Chemical Science*," by JAMES MACTEAR, F.C.S., F.I.C., Member of the International Jury, Paris, 1878.

Taking up the subject at the point where the science is usually supposed to have originated—in the Arabian School of Philosophy in the 8th century—the author showed that the science was of much more ancient origin, and traced its history back through the medical science of the Greeks, Russians, Egyptians, &c., to Indian sources, where in all probability it was known and cultivated as a science fully 2000 B.C. The author also showed the unsatisfactory nature of the derivation of the name of the science from Chem or Chemia, as meaning dark, hidden, or black, or even Dshem, to find, as it has been explained by all previous authors on the subject, and stated that his own researches into the subject resulted in deriving the name indirectly from the word Khams—an Arabic word of Sanskrit origin—meaning fire, or rather from its compound Khamis, meaning *the fifth*. As is well known the ancient Hindoos recognised five elementary types—water, fire, earth, air, and ether, the latter being the prin-

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* The value of Δ diminished by unity expresses the ratio of the number of the molecules of the more complex type to the whole number of molecules. Thus, if $\Delta = 1{\cdot}20$, in the case of peroxide of nitrogen there are 20 molecules of the type N_2O_4 to 80 of the type NO_2, or in the case of perchloride of phosphorus there are 20 molecules of the type PCl_5 to 40 of the type PCl_3 and 40 of the type C_2. A consideration of the varying values of Δ is therefore more instructive than that of the values of D, and it would in some respects be better to make the comparison of theory and experiment with respect to the values of Δ.

ciple, or type, of active force or motion which caused the changes in the condition of the elementary types or their combinations. From a consideration of those and other facts the author derives the title of the science from—

Al-Khamis,
(The Fifth),

meaning *The Science of Force or Change.* No more perfect descriptive title could be found for it, even in our present enlightened age.

A cordial vote of thanks was given to Mr. Mactear for his interesting paper.

NOTICES OF BOOKS.

Technical Vocabulary, English and German. Technisches Vocabular für Technische Lehranstalten und zum Selbst studium für Studirende, Techniker und Industrielle. Von Dr. F. J. Wershoven, mit einem Vorwort von A. von Kaven, Director der Technischen Hochschule in Aachen. Leipzig: Brockhaus.

As it is intimated in the preface, the student, in acquiring a foreign language, learns every portion of it sooner than the technical phraseology of the sciences and the useful arts. The ordinary grammars, vocabularies, and dictionaries avoid such subjects,—often, indeed, from ignorance on the part of their authors. That such a state of things should be perpetuated in an eminently industrial age is no less strange than lamentable. To an Englishman, surely the French or the German of the laboratory and the workshop must be more important than the French or German of the feuilletonist and the play-wright. We must there ore welcome every attempt to render the technological literature of each country more widely intelligible among its neighbours.

The present little work may be pronounced remarkable for its general accuracy. We find, under the alkali manufacture, "boot-pan" in place of "boat-pan," but this is a mere misprint. The terms "metalloids" for non-metallic bodies, and "Daltonism" for colour-blindness, are now rarely, if at all, used by accurate English writers.

As a matter of course, when a writer gives in the compass of 220 pages the technical phraseology of mechanics, of the various branches of physics, of chemistry, meteorology, geology, metallurgy, photography, galvano-plastics, railways, land surveying, glass-making, pottery, textile manufactures, paper-making, sugar-extraction, and brewing, he cannot be expected to go into every detail in any of these sciences and arts. But no one, we submit, could have done more in a space so limited. Some of the most important chemical arts have certainly been omitted, such as dyeing, tissue-printing, colour-making, tanning, soap-making, &c. Perhaps it might have been better if the author had divided the matter into two distinct volumes, a mechanical and a chemical, since many students and technologists who are deeply interested in the arts just enumerated will find certain sections of this work, *e.g.*, that on railways, quite out of their sphere, and *vice versa*.

Still, whilst we venture to throw out these suggestions, we can do no other than pronounce the work, such as it is, a true and an accurate *multum in parvo*.

Royal Institution.—The Managers have awarded the Actonian Prize of £105 to G. S. Boutger, F.L.S., F.G.S., for an essay on "The Structure and Functions of the Retina in all Classes of Animals, viewed in Relation with the Theory of Evolution." Professor Tyndall will give the first of his Christmas Lectures (adapted to an educated juvenile auditory) on Saturday, December 27, at 3 o'clock.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 22, December 1, 1879.

Observations on M. Trécul's last notice on Chlorophyll.—M. Chevreul.—The author asks, first, Whether M. Trécul has found the crystalline form of chlorophyll soluble without residue in alcohol and ether? This question, having been answered in the affirmative, he expresses his regret at not having known of his discovery in 1865. He then asks whether M. Trécul regards chlorophyll as a simple product of the organism, as would appear from its solubility in alcohol and ether and from its crystalline character? M. Trécul's opinion is that the chlorophyll which he terms globular is a living organ, the producer of the chemical principle crystalline chlorophyll, and the reducer of carbonic acid in the green living leaf. M. Chevreul then, referring to certain interesting experiments by M. Cloëz, asks, What is the part played by chlorophyll? Is it a constituent part of the organ, or its presence merely accessory?

Certain Properties of Glucose.—E. Peligot.—On treating glucose with alkalies, the author has obtained a crystalline compound to which he gives the name of saccharin. Its composition, $C_{12}H_{11}O_{11}$, is that of saccharose, but it does not ferment in presence of yeast, and it is almost insipid, with a faint after taste recalling that of Glauber's salt. It is only reduced by the cupric alkalotartrates after a prolonged boiling.

Crystalline Form and Optical Properties of Saccharin.—M. des Cloizeaux.

Measurement of Quantities of Electricity.—G. A. Hirn.—The author criticises the various methods proposed for measuring electricity by its effects, and in particular to the recent investigations of Prof. Villari.

Remarkable Electric Phenomenon.—E. Lamarre.—At the commencement of a violent snowstorm the author perceived little luminous tufts at the end of each of the steel rods of his umbrella, and heard a sound like the humming of an insect. On approaching his hand to one of the lights he felt a slight shock in the first two joints, and the light disappeared.

Separation of Phosphoric Acid from the Sesquioxides of Iron and Alumina.—P. Derome.—See p. 292.

Composition of the Horn of the Stag.—A. Bleunard.—Stag's horn is a lower homologue of coagulated egg-albumen, but is more highly hydrated.

Determination of Chlorine in Various Seeds and Forage Plants.—R. Nolte.—The author gives a table of his results, which differ from the older determinations, and show that chlorides form a part of every vegetable diet.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 13, 1879.

Formula of Quinhydron.—H. Wichelhaus.—The author considers that the formula $C_{18}H_{14}O_6$ is established beyond doubt.

Reaction for Phenyl-glyoxylic Acid.—L. Claisen.—If to a solution of this acid in benzol there is added concentrated sulphuric acid the mixture, after standing for a short time and agitation, takes a deep red colour, which soon passes into a violet-blue. On the addition of water the colouring-matter passes with an intense crimson hue into the supernatant layer of benzol, from which it may be separated by evaporation, or on the addition of petroleum-ether. The derivatives of the acid, its amides and ethers, and benzoyl cyanide behave in a similar manner. Meta-nitro-phenyl-glyoxylic acid yields a splendid crimson-red colouration and ortho-nitro-benzoyl-cyanide a blue-green.

Aldehyd Collidin.—A. Wischnegradsky.—On oxidising collidin by means of chromic acid the author obtained an acid, $C_8H_7NO_4$, forming fine white prisms, readily soluble in hot water, and easily volatilised by heat, though with partial carbonisation.

Decomposition of Ethylamin Hydrochlorate by the Action of Heat.—M. Fileti and A. Piccini.—The gases evolved consist of a mixture of ammonia, mono- and di-ethylamin, ethyl-chloride, and ethylen.

A New Method of the Formation of Hyponitrous Acid and of Hydroxylamin.—W. Zorn.—If in the electrolysis of sodium nitrite a mercury electrode is employed at the negative pole, and the process is interrupted when all the nitrite is consumed, then, on adding acetic acid and silver nitrate, nitrosyl silver is deposited in abundance. Hydroxylamin is also produced.

Behaviour of Cymol in the Animal Body.—Oscar Jacobsen.—Cuminuric acid, $C_{12}H_{15}NO_3$ appears in the urine. The author describes its properties, and those of certain of its salts.

A Remarkable Oxidation-product of Cholic Acid.—P. Latschinoff.—On oxidising impure cholic acid with potassium permanganate or nitric acid, the author obtains a mixture of crystallised acids, of which he here describes one, the choloidanic acid. No fixed fatty acids were obtained on a similar treatment of pure cholic acid. Choloidanic acid is isomeric with camphoric acid, but distinct from all the isomers of the latter hitherto described.

Direct Separation of Manganese and Iron.—F. Beilstein and L. Jawein.—The authors propose two processes. In the one the solution of the two metals is poured into an excess of a concentrated aqueous solution of potassium cyanide. After standing from half an hour to an hour the precipitate re-dissolves, and only a slight turbidity remains. The whole is filtered, the residue is dissolved in a few drops of dilute hydrochloric acid, the solution is mixed with excess of potassium cyanide, and the clear solution is added to the filtrate. All these operations are performed in the cold. Solid iodine is then added till the liquid appears brown, when any traces of free iodine are removed by the addition of a few drops of free alkali. The complete separation of the manganese is ascertained by adding iodine to a small portion of the liquid, decanted or filtered; heating very gently and adding soda-lye. The liquid should remain clear. The precipitated manganic oxide is filtered off, washed, dissolved in hydrochloric acid, precipitated with ammonium sulphide at a boil, and weighed as manganese sulphide. Second process:—The salt of the two metals is dissolved in concentrated nitric acid (1·35), heated to a boil and kept at this temperature, whilst potassium chlorate is gradually added in small portions. The liquid is diluted with water and filtered. The precipitate when washed is always found to contain iron. It is therefore re-dissolved in hydrochloric acid, evaporated to dryness, and the residue taken up in concentrated nitric acid, and treated again with chlorate of potassa at a boil. A peroxide is now precipitated containing very small traces of iron.

Determination of Acetyl by Means of Magnesia.—Hugo Schiff.—The magnesia used must be precipitated from magnesium sulphate or chloride (free from iron), avoiding excess of alkali, and kept as a paste under water.

Constitution of Ellagic Acid.—Hugo Schiff.—Not suitable for abstraction.

Contributions to a Knowledge of the Spontaneous Oxidation of Manganese Monoxide, with Reference to the Regeneration of Manganese.—J. Post.—The rapidity of the action is much promoted by exposing manganous oxide to the air in a thin layer. On the small scale an addition of soap with the aid of constant agitation was found advantageous. The addition of an excess of alkali or of lime increases the yield, the former being more beneficial.

Hydroxy-isobutyl-formic Acid.—W. von Miller.—The compound formed on the oxidation of isobutyl-formic acid by potassium permanganate, and which precedes the formation of dimethyl-acrylic acid, is β-oxy-isobutyl-formic acid.

Hydroxy-ethyl-methyl-acetic Acid.—W. von Miller.—On distilling this acid with sulphuric acid there was formed no methyl-crotonic acid.

A New Salt of an Iridium Base.—K. Birnbaum.—The author points out that most of the researches on the iridium bases date from a time when the metal had not been obtained in a state of purity.

Behaviour of Anhydrous Calcium Oxide with Anhydrous Carbonic Acid.—K. Birnbaum and M. Mahn.—The melting-point of zinc is the temperature at which anhydrous calcic oxide begins to absorb carbonic acid under the ordinary atmospheric pressure. A definite compound is not formed, as at this temperature calcium carbonate is within the limits of dissociation.

Excitement of Oxygen by Nascent Hydrogen.—F. Hoppe-Seyler.—The author considers that every attempt to explain the vital process in plants and animals necessarily demands the assumption of a plentiful source of the activation of oxygen within the organism. He has convinced himself that the formation of free hydrogen takes place only in the absence of oxygen, and that on the access of oxygen to putrescent liquids not alone the nascent hydrogen is oxidised, but that energetic processes of oxidation are set up.

On Chlorophyll.—F. Hoppe-Seyler.—The author is engaged with the examination of chlorophyllan, a crystalline colouring-matter, obtained from the residue of the alcoholic extract of grass, after the erythrophyll of Bougarell has crystallised out.

A Correction.—W. Ramsay.—Refers to *Berichte*, xii., p. 1024.

An Explanation.—C. Willgerodt.—See *Berichte*, xi., 1792, and xii., 1319.

Perchloric Acid as a Reagent for Alkaloids.—G. Fraude.—The author has examined the action of perchloric acid upon the alkaloids of the quinin group, the opium bases, veratrin, caffein, atropin, nicotin, and coniin. All these give no colour-reactions, which, however, occur with aspidospermin and the strychnos bases. The colourations are sufficiently permanent to admit of spectroscopic examination.

On Aspidospermin.—G. Fraude.—There are two varieties of aspidospermin obtained respectively from two varieties of the *Aspidosperma quebracho*, the "blanco," and the "colorado." The author gives an account of some of the salts of aspidospermin and its reactions.

Maleic Acid from Bichloracetic Acid.—S. Tanatar.—The nature of this paper will appear from the title.

Amido-anthraquinon from Anthraquinon-mono-sulphonic Acid.—H. R. v. Perger.—The author has examined the action of ammonia upon the above-mentioned acid.

Action of Phosphorus Penta-chloride and Hydriodic Acid upon Saccharic Acid.—H. de la Motte.—The author, having heated pure potassium saccharate with 6 molecules of phosphorus penta-chloride, obtained chloromuconic acid, $C_6H_4Cl_2O_4$. He finds that this acid, whether obtained from saccharic acid or mucic acid, contains, further, 2 mols. crystalline water.

Certain Derivatives of Santonin.—S. Cannizzaro and G. Carnelutti.—Santonin, mixed with red phosphorus and heated for a long time to ebullition with an excess of concentrated hydriodic acid, yields santonous acid, a powerful monobasic compound, containing an atom of oxygen ess than the isomeric santonic acid. The authors have examined the methyl-ether of this acid.

The so-called Digallic Acid.—P. Freda.—The substance characterised by Schiff as digallic acid cannot be obtained.

Action of Boron Fluoride upon Aceton.—F. Landolph.—The author has obtained and isolated α-fluoboric aceton and a β-fluoboric aceton.

Two New Hydrofluoboric Acids and Fluoboric Ethylen.—F. Landolph.—The respective formulæ of these acids are $Bo_2O_7H_4.3HFl$ and $Bo_2O_9H_4.2HFl$.

Analysis of Organic Fluo and Boro Compounds.—F. Landolph.—Not suitable for abstraction.

Potassa-melt of Rhamnetin.—St. Smorawski.—Among the products obtained are proto-catechuic acid and phloro-glucin. A substance which, like the quercetic acid of Hlasiwetz, gives with alkalies an intense red reaction accompanied the crude proto-catechuic acid.

Sequel to the Decomposition of the Oxy anthraquinons by Potassa.—C. Liebermann and J. Dehnst.—Para-oxy-benzoic acid was observed along with benzoic and proto-catechuic acid in the potassa-melt of monosulpho-anthraquinonic acid.

Constitution of the Camphor Compounds.—M. Balle.—Not suitable for abstraction.

Behaviour of Indigo-white with Potassium Pyrosulphate.—A. Baeyer.—There exists a compound of indigo-white which possesses the general properties of Baumann's potassium sulph indoxylate, and according to its origin is a sulpho phenolate.

Aromatic Sulpho-ureas.—C. Feuerlein.—The author has analysed the phenyl-cyan-imid hydrate, and has succeeded in forming a platinum and a silver compound. The attempts at preparing the platinum and the silver salts of mono-phenyl-guanidin gave only very small precipitates, which proved to be the corresponding phenyl-cyanimide compounds.

The Acid of Drosera Intermedia.—G. Stein.—The acid in question is the citric.

Changes of Ammonium Isæthionate at Elevated Temperatures.—F. Carl.—The results indicated that the substance melting at 196° to 198° is the ammonium salt of a new acid, the di-isæthionic, formed by the union of 2 mols. ammonium isæthionate, with the simultaneous removal of a mol. of water.

The Constitution of the Phenyl Halogen Propionic Acids.—E. Erlenmeyer.—Not suitable for abstraction.

Certain New Colouring-matters.—P. Greiff.—If one part of chloranil is allowed to act upon two parts of dimethyl-anilin a deep blue colouration is observed, even in the cold. On heating to 50° the reaction is complete, and a bronze-coloured melt is obtained, which is insoluble in water but gives up to alcohol and acetic acid a deep violet-blue colour of great purity. If instead of dimethyl-anilin, methyl-diphenyl-amin is employed, a blue colour is obtained, more beautiful than any yet known. The reactions are very complete and the yield is high.

New Determinations of the Densities of Solid Organic Compounds.—H. Schröder.—This important paper consists chiefly of tabulated results. The author remarks that there are 29 compounds, 23 of which contain the benzol-nucleus, whose volumes are almost exact multiples of 5·91. The elements carbon, hydrogen, oxygen, and nitrogen in the solid state generally take up the space of 1 stere.

Oxidation of Cholic Acid.—H. Tappeiner.—A controversial notice, having reference to the paper of Latschinoff (*Berichte*, xii., 1022).

Diffusion-Experiments on Solutions of Saline Mixtures of an Acid Reaction.—F. Hinteregger.—In most cases the acid diffuses more rapidly than the base, but deviations from this rule occur, as in the case of phosphates. The mixture of free hippuric acid and sodium hippurate behaves in the very opposite manner.

Quinon-like Body Occurring in Ag. atrotomentosus.—W. Thörner.—Not susceptible of useful abstraction.

A New Organic Acid in Agaricus Integer.—W. Thörner.—The composition of this acid is $C_{15}H_{30}O_2$. It crystallises from alcohol in snow-white needles, arranged in little tufts and melting at 69½° to 70°.

Action of Hydrocyanic Acid upon certain Diazo Compounds.—S. Gabriel.—It has hitherto not been shown that the cyanogen residue can be simply transferred by the action of compounds containing the cyanogen group upon the diazo compounds.

Certain Derivatives of Sulphacetic Acid.—S. Gabriel.—The author has succeeded in producing acids of the formula $R_{II}(S.CH_2.COOH)_2$ from bibasic mercaptans and phenyls.

Action of Ammonia and the Amines upon the Quinons.—T. Zincke.—In consequence of the notice issued by Sommaruga (xii., 979) with respect to the investigation of these reactions, the author publishes the results on the same subject previously obtained by some of his pupils.

The Sugar of Populin.—E. O. von Lippmann.—The sugar obtained on the decomposition of populin is glucose.

Occurrence of Tricarballylic Acid and Aconitic Acid in Beet-juice.—E. O. von Lippmann.—The citric, aconitic, and tricarballylic acid accompany sugar in beet-juice.

The Phthalein of Hæmatoxylin.—E. A. Letts.—The author has not succeeded in obtaining this phthalein in the form of crystals. The alcoholic solution dries up to a gummy mass insoluble in water. With potassa-lye the phthalein yields a purple-red colouration totally different from that which the same reagent gives with solution of hæmatoxylin.

Certain Derivatives of Tri-ethyl Citrate.—J. Conen.—The author describes the action of phosphorus trichloride and penta-chloride upon this ether.

Formation of Potassium Ferro-chromate and the New Corresponding Ammonium Compound.—C. Hensgen.—The contents of this paper will sufficiently appear from the title.

Behaviour of Ammoniac Gum Resin on Distillation with Zinc Powder.—G. L. Ciamician.—The products of this gum-resin (salicylic acid, ortho-ethyl-phenol, &c.) are very different from those obtained by a similar process from the so-called terpen-resins. The portions boiling at higher temperatures in the case of gum-ammoniac consist of one of the higher hydrocarbons of the benzol-series, whilst from abietic acid and gum-elemi we obtain hydrocarbons of the naphthalin series.

Lauric Acid and its Transformation into Undecylic Acid.—F. Krafft.

Tri-decylic Acid, Penta-decylic Acid, and Margaric Acid.—F. Krafft.—These two papers do not admit of useful abstraction.

Cynurenic Acid.—M. Kretschky.—On treatment with zinc powder in a current of hydrogen this acid yielded quinolin almost perfectly pure.

State of the Alkaline Phosphates in Aqueous Solution.—J. M. van Bemmelen.—The record of diffusion experiments. In every moment a certain number of molecules of Na_3PO_4 are formed and again decomposed, the number being a function of the temperature and the quantity of water.

The Existence of Double Salts in Solutions.—P. H. B. Ingenhoes.—The author's experiments refer chiefly to barium aceto-nitrate, calcium aceto-chloride, and barium formio-nitrate. The results are shown in the form of tables.

Condensation Products of Tertiary Aromatic Bases. —Otto Fischer.—The author's researches embrace the oil of bitter almonds and dimethyl-anilin, the hydrochlorate of tetra-methyl-diamido-triphenyl-methan, bitter almond oil green (benzoyl green), cuminol and dimethyl-anilin, methylal and dimethyl-anilin, benzo-phenon chloride and dimethyl-anilin, and the phthalein of dimethyl-anilin.

Condensation Products of the Aldehyds with Primary Aromatic Bases.—Otto Fischer.—The author has obtained a new base, to which he gives the name of diamido-triphenyl-methan.

Apparatus for Determining the Heat of Combustion. —F. Fischer.

Apparatus for the Determination of Oxygen in Atmospheric Air.—F. Fischer.—These two papers cannot be intelligibly abstracted without the accompanying illustrations.

La Correspondance Scientifique.
October 28, 1879.

Action of Solar Light upon Vegetation in Northern Regions.—Nicolas de Nasakine.—The author maintains that the aroma of fruits increases with the latitude, while the sweetness decreases. The foliage of northern trees is remarkable for its deep shades of green, and the flowers have colours exceptionally vivid. Many herbs, such as carraway, are richer in essential oils in Norway than in more southern regions. The author ascribes these differences to the influence of the prolonged light of the summer months.

MISCELLANEOUS.

Royal Academy of Arts.—At a general assembly of Academicians, held on the 5th instant, Mr. A. H. Church, late of Cirencester, was elected to the Professorship of Chemistry in the Royal Academy.

Separation of Fats and Soaps.—Justus Wolff.—The mixture of soap and fat is comminuted as far as possible, mixed with from 10 to 20 parts of purified aniline, and digested in the water-bath, stirring and crushing continually for half to three-quarters of an hour. The solution is filtered when cold, and the residue is several times treated with aniline. In the residue is found all the soap, whilst the resins and fats are in the solutions. These are poured together, mixed with hydrochloric acid and with 3 or 4 parts of water, and when cold shaken with ether. The ethereal solution on evaporation leaves the unsaponified fats and resins. The aniline must be free from benzol and nitro-benzol.—*Zeitsch. Anal. Chemie*, xviii., 570.

NOTES AND QUERIES.

Association of Sulphuric Acid Manufacturers.—Can any reader of the Chemical News furnish me with the name and address of the Secretary or other official representative of an Association formed last year among sulphuric acid manufacturers, with the view of developing sources of supply of sulphur other than pyrites, in consequence of the combination among pyrites companies to raise the price of pyrites?—Vitriol.

MEETINGS FOR THE WEEK

Monday, 22nd.—London Institution, 5.
—— Society of Arts, 8. (Cantor Lecture). "Chemistry of Bread and Bread Making," Dr Graham.
Tuesday, 23rd.—Civil Engineers, 8. (Anniversary).
Saturday, 27th.—Royal Institution, 3. Prof Tyndall. First Christmas Lecture on "Water and Air,"

NOTICE.

Friday next being a Bank Holiday, The Chemical News *will be published on Wednesday, the 24th inst. Advertisements should reach the Office before 2 p.m. on Tuesday, the 23rd inst.*

Boy Court, Ludgate Hill, December 18, 1879.

PROFESSOR TYNDALL'S CHRISTMAS LECTURES
AT THE
ROYAL INSTITUTION.
Subject:—WATER AND AIR.

These Lectures will, by permission of Dr. TYNDALL, be reported verbatim for THE JOURNAL OF SCIENCE. Lecture I. will appear in the January number.

Seventeenth Year of Publication.
THE
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UNIVERSITY COLLEGE, BRISTOL.
CHEMICAL PROFESSORSHIP.

The Council invite Applications for the Chair of Chemistry. Salary, £300, with a share of the Students' Fees. Applications, with testimonials, to be sent not later than 9th February, 1880. Further information may be obtained from the Principal on application to EDWARD STOCK, M.R.C.S., Secretary.

The Gas Committee of the Corporation of Manchester are prepared to receive Tenders for the supply of Oxide of Iron, suitable for purification purposes to their Gaythorn and Rochdale Road Works, in such quantities as may be from time to time required during twelve months, commencing next spring.

Forms of Tender and full particulars can be obtained on application to Mr. George B. Jackson, Town Hall, Manchester.

Tenders endorsed "Tender for Oxide of Iron" and addressed to the Chairman of the Gas Committee must be delivered here not later than Wednesday, the 14th day of January next. The Corporation do not bind themselves to accept the lowest or any tender.—By order,
JOS. HERON, Town Clerk.
Town Hall, Manchester,
December 16, 1879.

The Prestolee Alkali Works, Farnworth, near Bolton, Lancashire, fitted with costly plant, machinery, and apparatus for the manufacture of soda-ash, bleaching-powder and liquor, and sulphuric acid, in complete working order. With possession

MESSRS. FULLER, HORSEY, SONS, and CO., are instructed to SELL by AUCTION, at the Palatine Hotel, Manchester, on Friday, January 16th, at 3 precisely, in one lot (unless an acceptable offer be previously made by private contract), the PRESTOLEE ALKALI WORKS, a freehold property, having a superficial area of 95.741 square yards of land, subject to chief rents amounting to £407 13s 9d per annum, with the buildings, plant, machinery, and apparatus erected thereon capable of manufacturing monthly a product exceeding in the aggregate 2000 tons of soda-ash, bleaching-powder and liquor (by Weldon's patent process), and sulphuric acid, also caustic soda and muriatic acid. The amount expended in the construction of these works has been very large. A valuation was made with great care in 1874 by Messrs. Holmes and Son, the well-known valuers, of Manchester; their estimate then amounted to £99,900, and since that time a sum exceeding £10,000 has been expended. The whole of the works and plant have been well kept, and are conveniently arranged for working. The Bury, Bolton, and Manchester Canal, which forms one boundary of the property, affords facility for economical water carriage, and the Lancashire and Yorkshire Railway is within a very short distance. There is a plentiful supply of water for all manufacturing purposes free of cost, from the river Croal, and coals are raised from pits in the immediate neighbourhood. Pyrites, salt, lime, and limestone are all brought by boats direct to the wharf on the canal. The works may be economically worked with a small capital, as arrangements may be made with the vendors for a very considerable portion of the purchase-money to remain upon mortgage. Large profits have been realised in the past, and the high reputation of the Prestolee manufactures in the market will ensure to an energetic man, even at the existing low prices, an ample return for his capital invested, and possession of works not surpassed for completeness or compactness by any in the kingdom. May be viewed till the sale. Printed particulars may be had at the works; at the Palatine and Queen's Hotels, Manchester; of Messrs. Wakeman and Bleeck, Solicitors, Warminster; of Messrs Christopher and Son, Solicitors, 28, Argyll Street, Regent Street, W.; and of Messrs. Fuller, Horsey, Sons, and Co., 11, Billiter Square, London, who are empowered to treat for the disposal by private contract, or an offer for renting would be entertained

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S, Ardwick Chemical Works Manchester.

THE CHEMICAL NEWS.

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THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 292.)

II. ON THE APPLICATION OF THE PERIODIC LAW TO THE SYSTEM OF ELEMENTS.

THE system of elements possesses not only a purely pedagogic importance as a means of learning more easily the different facts which are grouped in a systematic manner and united one to another, but also a scientific importance, inasmuch that it shows us new analogies, and thus opens up new roads for the research for elements. All the systems known up to the present can be placed in two distinct categories.

Into one of these categories (artificial systems) enter the systems which are based on some few characters of the elements. For example, the systems of division of the elements according to their affinity, according to their electro-chemical properties, according to their physical properties (or division into metals and metalloids), according to the manner in which they behave in the presence of oxygen and of hydrogen, according to their atomicity, &c. These systems, in spite of their evident defects, deserve some consideration, for they have the merit of a certain exactness, and each of them has contributed in a special direction to the progressive elaboration of chemical ideas.

The systems of the second category (natural systems) establish, according to members of different and purely chemical properties, groups of analogous elements. The well-known results of these systems have obtained for them the preference over the artificial systems. However, they are also stained with serious faults.

1st. The partition of elements does not rest upon invariable principles; also such elements as Tl, and even Ag and Hg, &c., have been placed in different groups. Na and K, Li and Rb, and often Tl also, have been frequently placed among the alkaline metals, although there exist between K and Na, in spite of the small difference between their atomic weights, more difference of properties than there is between K, Rb, and Cs. Na and all compounds of Na have a greater density than K and its corresponding compounds, although the atoms of sodium are lighter than the atoms of potassium.

NaCl and KCl crystallise in cubes (KCl often crystallises in a mixture of cubes and octahedra). However, we do not meet with isomorphous mixtures in nature, and we have obtained none artificially. According to Stassfurt we often meet with distinctly separate crystals of NaCl and KCl, one by the side of the other.

In the same manner the situation of Mg relative to Ca, or of Pb relative to Ba, Sr, and Ca, or of Tl relative to K, Rb, and Cs, is doubtful. In consequence of this want of fixed principles of separation the results of the natural systems are very uncertain.

2ndly. Some elements are without analogies, such as Au, Al, B, F, Ur, &c.

3rdly. There is no general expression for the reciprocal relations between the different groups; they could not be united in one whole. Thus these systems are always incomplete.

The periodic law possesses, in the forms of oxides and in the atomic weights, invariable numerical values for the distribution of the elements. It permits us, then, to group together the elements which have in reality a great deal of resemblance, and it answers at the same time to the principles which have successively led to artificial systems. It gives us the means to erect an unarbitrary system, as complete as possible. The preceding considerations, as well as those which are to follow, show up its advantages and properties. I will only insist on the manner of employing it to determine the places of some elements which have given rise to different interpretations. I must now commence with some general remarks.

The position of an element, R, in the system is found by the series and the group to which this element belongs, and therefore by the elements X and Y, which are next to it, one in front and the other behind in the same series, and also by two elements in the same group, the element R′, whose atomic weight is the next smaller, and the element R″, whose atomic weight is the next larger. The properties of R can be determined from the known properties of X, Y, R′, and R″. We find, for example, in the system the following series:—

Series of order $(n+2)$ $X'\ R'\ Y'$
„ „ (n) $X\ R\ Y$
„ „ $(n+2)$ $X''R''Y''$
$R'' - R = \text{nearly } R - R' = \text{about } 45.$

Therefore, to find the properties of analogous compounds, we can establish proportions and find average values; the properties of all the elements are, properly speaking, in an intimate and mutual dependence. I call *atomanalogy* of an element the relation which joins R to X and Y, on the one hand, and to R′ and R″ on the other hand. Thus As and Br on the one hand, and S and Te on the other, are the atomic analogues of Se, whose atomic weight is the medium one, viz.,—

$$78 = \left(\frac{75+80+32+125}{4}\right);$$

and, for example, the properties of SeH_2 answer to this atomic weight, because SeH_2 occupies the middle place between AsH_3-BrH and SH_2-TeH_2, &c. It is only in the series and in the ends of groups that the atomanalogies are not quite valid, although we can there also see clearly the reciprocal relations, which can be shown conditionally by the arithmetical proportions, for example—

$$X' : X = R' : R = Y' : Y \text{ or } X' : R' = X : R = X'' : R''.$$

These reciprocal relations, to which the system founded on the periodic law leads us, furnish the possibility of explaining many isolated and doubted facts.

Different opinions have been given on the position of beryllium in the system since the researches of Awdeeff. He gives to the oxide the formula of magnesia; besides, glucina is very like magnesia in its properties. The periodic law gives the following proofs in favour of the formula BeO. If we adapted the formula Be_2O_3, the atomic weight of beryllium would be $\frac{3}{2}9{\cdot}4=14{\cdot}1$. In this case this element could not enter the system, because it would be by the side of nitrogen, and would have to possess very acid properties, and also to form higher oxides, having as formulæ Be_2O_5 and BeO_3, of which it is not capable. If, on the contrary, we adopt BeO as the formula for its oxide, and 9·4 for the atomic weight of the metal, this element, conforming to the formula of oxides and to all its properties, would be between L = 7 and B = 11. The following proportions will suffice to show what I mean:—

1st. Be : Li = B : Be.

In effect the basic properties are more feebly shown in BeO than in Li_2O, and much more feebly in Be_2O_3 than in BeO. Chloride of beryllium is more volatile than chloride of lithium, and much more volatile than chloride of boron.

2ndly. Be : Mg = Li : Na = B : Al.

Oxide of beryllium is a less energetic base than MgO. Again, Li_2O reacts more feebly than Na_2O, and B_2O_3 more feebly than Al_2O_3. This is why glucina dissolves in KHO.

The salts of BeO and of MgO do not present an absolute isomorphism; occasionally they show considerable differences in their crystalline forms. This fact is without importance, because the salts of Li and of Na and the compounds of B and of Al are none of them completely isomorphous.

Fluoride of beryllium is soluble in water, fluoride of magnesium is not; fluoride of boron is soluble, and fluoride of aluminium is not.

3rdly. Be : Al = Li : Mg = B : Si.

If, in spite of the difference of the formulæ of the oxides, oxide of beryllium corresponds in many respects to aluminium, Li_2O and MgO will also possess analogous properties; the same is true for B_2O_3 and SiO_2. If, still further, the volume of an equivalent of BeO equal to—

$$\frac{25\cdot4}{3\cdot05} = 8\cdot3,$$

approaches in volume an equivalent of aluminium equal to—

$$\tfrac{1}{3}Al_2O_3 = \frac{102\cdot6}{4\cdot0} = 8\cdot5,$$

this concordance is repeated for the corresponding compounds of Li and $\frac{1}{2}$Mg, as well as for $\frac{1}{3}B_2O_3$ compared with $\frac{1}{2}SiO_2$.

The volume of LiCl = 21; therefore the volume of $Li_2Cl_2 = 42$, which corresponds to $MgCl_2 = 44$; the volume of $BCl_3 = 87$; therefore that of $\frac{2}{3}BCl_3 = 58$, which corresponds to $\frac{1}{2}SiCl_4 = 56$ ($SiCl_4 = 112$); the volume of $B_2O_3 = 39$; therefore the volume of $\frac{1}{3}B_2O_3 = 13$; whilst the volume of SiO_2 (amorphous) = 27, and, therefore, $\frac{1}{2}SiO_2 = 13\cdot5$.

Again, does not Rose's observation, relative to the proximity which the volumes of equivalents of glucinum and of aluminium present, show the concordance which exists between the formulæ of the oxides. If BeO crystallises in the characteristic forms for Al_2O_3, ZrO_2 crystallises in the same manner.

Therefore, the position of Be in the system would be elucidated on all points, so that we could form an opposition group to Li, Na, K, Rb, Co, viz., the group Be, Mg, Ca, Sr, Ba, parallel in all respects.

In the same way the position of B relatively to C, Si, Al is indicated by what precedes. So I think it is sufficient to make the following proportions:—B : Al = Be : Mg; B : C = Be : B; B : Si = Be : Al. We can still add B : P = C : S, as it appears, if we examine the tables, and if we consider that B furnishes the compounds BCl_3, B_2O_3, BH_3O_3, which correspond to PCl_3, P_2O_3, PO_3H_3, &c., these circumstances coincide with those that we observe relative to CO_2, C_2, C_2H_2, CH_2O_2, and to SO_2, S_2H_2, SH_2O_2.

(To be continued.)

DR. ANGUS SMITH'S REPORT AS INSPECTOR UNDER THE ALKALI ACTS.

Rarely have we met with a "Blue Book" at once so interesting and so satisfactory as Dr. Angus Smith's recent reports as Inspector under the Alkali Acts;—interesting from the importance of the subject dealt with, and satisfactory because the object of the Acts is being successfully carried out at a *minimum* of annoyance and trouble to all concerned. Our first reflection after examining the ensuing pages is, that Dr. Angus Smith still continues to approve himself "the right man in the right place." His thorough knowledge of industrial chemistry, his suggestive and fruitful mind, his tact, courtesy, and patience, his clear oversight of the whole field of operations, and of the rival interests to be dealt with, cannot be too highly esteemed, and have won for him golden opinions among all competent judges. His method of leading instead of driving the chemical manufacturers, and of substituting, whenever possible, remonstrance and advice for summonses and fines, is perhaps slow, but it is sure. We know well that a part of the British public value remedial agencies and reforms of every kind simply in proportion to the disturbance they create,—a preference which, by the way, is the very sheet-anchor of quackery. Dr. R. A. Smith remarks that:—"Some of the public would have preferred to see the inspectors frequently in court with cases of complaint, but I know well that information must grow, and habits must grow, and that to torment men into doing what required much time to learn, was to return to the old system of teaching by the cane instead of through the intellect."

As to the success attained in working the Act, we learn that while the law allows 0·2 grain of muriatic acid to escape per cubic foot of mixed gases, from many works the escape has passed into the second decimal place, and in No. 2 and 3 districts this is the case for the yearly average. Hence the inspectors are now able to show—what formerly was a mere guess,—that there are much more sulphur acids passing into the atmosphere than muriatic acid. There are chimneys using coal alone, *i. e.*, where nothing but the products of the combustion of fuel escape, and where the acidity is yet above 0·2, and in Widnes it is sometimes above 1·0 Hence it is idle to complain that in all South Lancashire there is a lowering of the tone of vegetation. We have often sought to show that were all the chemical works of Widnes and St. Helens swept away, so long as the coal is so rich in sulphur, beautiful trees are out of the question. We may further ask whether the prosperity of our manufactures is not, after all, of at least as much importance as the growth of trees in districts that never possessed any attractive scenery?

The attention of the inspectors has not been by any means confined to the escape of muriatic acid, sulphur, and nitrogen acids from chimneys and chambers. They have also expended much research on the gases evolved from the waste-heaps. Two objects have here to be kept in view; the abatement of the nuisance and the utilisation of the sulphur, now chiefly wasted. The escape of sulphuretted hydrogen, Dr. Angus Smith thinks, will never be entirely done away with till the Le-Blanc process is laid aside. This, again, is a consummation scarcely to be expected until "we learn to make ammonia from the nitrogen of the air and the hydrogen of water." In the meantime, a variety of methods have been proposed to minimise the evil. Dr. Mond seeks to oxidise the sulphur to a certain extent by blowing air through the mass fresh from the tanks and when the exact amount of hyposulphurous acid is formed capable of destroying the sulphide of hydrogen or of calcium remaining, he dissolves the soluble matter in water, and adds hydrochloric acid, which releases both the acids, so as to let them act on each other, when free sulphur is thrown down. This process has been used by Mr. Worsley, of Netham, near Bristol, who finds it remunerative.

At the Alkali Works of Dieuze any salts of iron are mixed with the mass, which is frequently stirred, so that the iron is alternately sulphurised and oxidised. At each sulphuration hyposulphite and bisulphide are formed. The two are mixed in proper proportions, so that on the addition of hydrochloric acid all the sulphur may be thrown down.

Dr. Smith lays before the public the outline of a new process which seems very promising, and which we should like to see tried on the large scale. If MnO_2 is added to liquid waste the sulphur is thrown down rapidly, and the calcium is oxidised. On exposing this manganese sulphide to air it is oxidised and sulphide is thrown out in a free state. If air is passed through the liquid in which the sulphide of manganese lies oxidation takes place and oxide of manganese is formed; part of the sulphur is at the same time converted into hyposulphurous acid. The use of hot water at high pressures, as proposed by Krause, is the most scientific method of dealing with solid waste, if not too costly.

Sulphuretted hydrogen is now successfully burnt to sulphuric acid on the large scale by means of a process devised by the late Mr. W. Hunt, of Wednesbury, and now carried out by Mr. P. Spence, of Manchester, at the Frizinghall Works, near Bradford.

The manufacture of coke, as at present conducted, involves waste and nuisance on a gigantic scale. We learn that the ammonia thus wasted in 1876 equalled 139,764 tons of sulphate of ammonia, representing a value of £2,795,280, without taking into account the coal-tar likewise sacrificed. Dr. Angus Smith is of opinion that every effort should be made to prevent this destruction, and recommends the coke-ovens of MM. Carvès and Co. to all who use coals containing from 25 to 33 per cent of volatile matter. The notion that it is impossible to produce a dense coke and to utilise the by-products is merely an apology for carelessness.

The author's remarks on the importance of securing the ammonia now wasted should in these times commend themselves to a much wider circle than merely to chemical manufacturers. It is to be noted that a great coal-owner asked Dr. Angus Smith, about thirty years ago, to make experiments on the best mode of saving the ammonia from the coke-furnaces, but was not willing to pay a shilling towards the expense of operations which must necesarily be conducted on a large scale. Upon which, says Dr. Smith, "I gave up the idea." Such is the general way in which chemists are treated.

We cannot too strongly commend this report to the notice of manufacturing chemists. In addition to other valuable information they will find in it the substance of several inventions which the author might legitimately have patented, but which he freely publishes for the benefit of the trade.

THE TESTING OF PETROLEUM ACT, 1879.

The Home Office has just issued the following instructions as to the mode of testing petroleum so as to ascertain the temperature at which it will give off inflammable vapour:—

The oil cup consists of a cylindrical vessel 2 inches diameter, $2\frac{2}{10}$ inches height (internal), with outward projecting rim 5-10th inch wide, $\frac{3}{8}$ inch from the top, and $1\frac{7}{8}$ inch from the bottom of the cup. It is made of gunmetal or brass (17 B.W.G.), tinned inside. A bracket, consisting of a short stout piece of wire bent upwards and terminating in a point, is fixed to the inside of the cup to serve as a gauge. The distance of the point from the bottom of the cup is $1\frac{1}{2}$ inches. The cup is provided with a close-fitting overlapping cover made of brass (22 B.W.G.), which carries the thermometer and test-lamp. The latter is suspended from two supports from the side by means of trunnions, upon which it may be made to oscillate; it is provided with a spout, the mouth of which is 1-16th inch in diameter. The socket which is to hold the thermometer is fixed at such an angle and its length is so adjusted that the bulb of the thermometer when inserted to its full depth shall be $1\frac{1}{2}$ inches below the centre of the lid. The cover is provided with three square holes, one in the centre, 5-10th inch by 4-10th inch, and two smaller ones, 3-10th inch by 2-10th inch, close to the sides and opposite each other. These three holes may be closed and uncovered by means of a slide moving in grooves, and having perforations corresponding to those on the lid. In moving the slide so as to uncover the holes, the oscillating lamp is caught by a pin fixed in the slide, and tilted in such a way as to bring the end of the spout just below the surface of the lid. Upon the slide being pushed back so as to cover the holes the lamp returns to its original position. Upon the cover in front of, and in line with, the mouth of the lamp is fixed a white bead, the dimensions of which represent the size of the test-flame to be used. The bath or heated vessel consists of two flat-bottomed copper cylinders (24 B.W.G.), an inner one of 3 inches diameter and $2\frac{1}{2}$ inches height, and an outer one of $5\frac{1}{2}$ inches diameter, and $5\frac{3}{4}$ inches height; they are soldered to a circular copper plate (20 B.W.G.) perforated in the centre, which forms the top of the bath, in such a manner as to enclose the space between the two cylinders, but leaving access to the inner cylinder. The top of the bath projects both outwards and inwards about $\frac{3}{8}$ inch; that is, its diameter is about $\frac{6}{8}$ inch greater than that of the body of the bath, while the diameter of the circular opening in the centre is about the same amount less than that of the inner copper cylinder. To the inner projection of the top is fastened, by six small screws, a flat ring of ebonite, the screws being sunk below the surface of the ebonite to avoid metallic contact between the bath and the oil-cup. The exact distance between the sides and bottom of the bath and of the oil-lamp is $\frac{1}{2}$ inch. [This statement relates to the distance between the sides and bottom of the *cup* and the walls of the *inner cylinder* which forms the air-chamber.] A split socket similar to that on the cover of the oil-cup, but set at a right angle, allows a thermometer to be inserted into the space between the two cylinders. The bath is further provided with a funnel, an overflow pipe, and two loop handles. The bath rests upon a cast-iron tripod-stand, to the ring of which is attached a copper cylinder or jacket (24 B.W.G.) flanged at the top, and of such dimensions that the bath, while firmly resting on the iron ring, just touches with its projecting top the inward-turned flange. The diameter of this outer jacket is $6\frac{1}{2}$ inches. One of the three legs of the stand serves as support for the spirit-lamp attached to it by means of a small swing bracket. The distance of the wick-holder from the bottom of the bath is 1 inch. The lamp is filled through the funnel. In both thermometers the capillary tube is widened at the top to prevent breakage through over-heating. The line on the scale of the long-bulb thermometer indicating 130° is rendered conspicuous by being drawn across the whole width of the ivory back. In a similar manner the line indicating 73° is specially marked on the round bulb thermometer. Two thermometers are provided with the apparatus, the one for ascertaining the temperature of the bath, the other for demining the flashing-point. The thermometer for ascertaining the temperature of the water has a long bulb and a space at the top. Its range is from about 90° to 190° F. The scale (in degrees of Fahrenheit) is marked on an ivory back fastened to the tube in the usual way. It is fitted with a metal collar, fitting the socket, and the part of the tube below the scale should have a length of about $3\frac{1}{4}$ ins., measured from the lower end of the scale to the end of the bulb. The thermometer for ascertaining the temperature of the oil is fitted with collar and ivory scale in a similar manner to the one described. It has a round bulb, a space at the top, and ranges from about 55° to 150° F.; it measures from end of ivory back to bulb $2\frac{1}{4}$ inches.

A model apparatus is deposited at the Weights and Measures Department of the Board of Trade.

Directions for Applying the Flashing Test.

1. The test apparatus is to be placed for use in a position where it is not exposed to currents of air or draughts.

2. The heating-vessel or water-bath is filled by pouring water into the funnel until it begins to flow out of the spout of the vessel. The temperature of the water at the commencement of the test is to be 130° F., and this is to be attained in the first instance either by mixing hot and cold water in the bath, or in a vessel from which the bath is filled, until the thermometer which is provided for testing the temperature of the water gives the proper indication; or by heating the water with the spirit-lamp (which is attached to the stand of the apparatus) until the required temperature is indicated. If the water has been heated too highly, it is easily reduced to 130° by pouring

in cold water little by little (to replace a portion of the warm water) until the thermometer gives the proper reading. When a test has been completed, this water-bath is again raised to 130° by placing the lamp underneath, and the result is readily obtained while the petroleum-cup is being emptied, cooled, and re-filled with a fresh sample to be tested. The lamp is then turned on its swivel from under the apparatus, and the next test is proceeded with.

3. The test-lamp is prepared for use by fitting it with a piece of flat plaited candle-wick, and filling it with colza or rape oil up to the lower edge of the opening of the spout or wick-tube. The lamp is trimmed so that when lighted it gives a flame of about 0·5 of an inch diameter, and this size of flame, which is represented by the projecting white bead on the cover of the oil-cup, is readily maintained by simple manipulation from time to time with a small wire trimmer. When gas is available it may be conveniently used in place of the little oil-lamp, and for this purpose a test-flame arrangement for use with gas may be substituted for the lamp.

4. The bath having been raised to the proper temperature, the oil to be tested is introduced into the petroleum-cup, being poured in slowly. In pouring in the oil to be tested great care should be taken not to splash it against the sides of the cup until the level of the liquid just reaches the point of the gauge which is fixed in the cup. In warm weather the temperature of the room in which the samples to be tested have been kept should be observed in the first instance, and if it exceeds 65° the samples to be tested should be cooled down (to about 60°) by immersing the bottles containing them in cold water, or by any other convenient method. The lid of the cup, with the slide closed, is then put on, and the cup is placed into the bath or heating-vessel. The thermometer in the lid of the cup has been adjusted so as to have its bulb just immersed in the liquid, and its position is not under any circumstances to be altered. When the cup has been placed in the proper position the scale of the thermometer faces the operator.

5. The test-lamp is then placed in position upon the lid of the cup, the lead-line or pendulum, which has been fixed in a convenient position in front of the operator, is set in motion, and the rise of the thermometer in the petroleum-cup is watched. When the temperature has reached about 66° the operation of testing is to be commenced, the test-flame being applied once for every rise of one degree in the following manner:—The slide is slowly drawn open while the pendulum performs three oscillations, and is closed during the fourth oscillation.

If it is desired to employ the test apparatus to determine the flashing-points of oils of very low volatility, the mode of proceeding is to be modified as follows:—The air-chamber which surrounds the cup is filled with cold water to the depth of 1½ inches, and the heating-vessel or water-bath is filled as usual, but also with cold water. The lamp is then placed under the apparatus, and kept there during the entire operation. If a very heavy oil is being dealt with the operation may be commenced with water previously heated to 120° instead of with cold water.—*Chemist and Druggist.*

CRYSTALLISATION OF CARBON.

At a meeting of the Glasgow Philosphical Society on Wednesday, Mr. James Mactear, of the St. Rollox Chemical Works, stated that on the 12th of this month he had sent a communication to Mr. Dixon, the secretary, giving the ascertained results of some discoveries he had made, but they were of such a startling nature that he thought it proper to have the note kept sealed until he had satisfied himself by all means in his power, and obtained more competent opinions than his own, as to the nature of these results. Since that time he had been in London and had shown the results to Profs. Tyndall, Warington Smyth, and others, and they were now in the hands of Mr. Maskelyne, of the British Museum. They were briefly these:—After having thought carefully from time to time over the subject, and made many abortive experiments extending over a period which dated back to 1866, he had at last succeeded in obtaining crystalline forms of carbon. They were perfectly pure and transparent, and had all the refractive power of diamonds. They had the crystalline form of diamonds, and resisted acids, alkalies, and the intense heat of the blowpipe. They also scratched glass, and the only other test that remained was as to whether they would scratch diamonds or be scratched by them, and as to the refractive index of the crystal itself and the measurement of the angle of the crystals. These tests, as he had said, had not been carried out, but they would be shortly, and he hoped to put some of the specimens before the society on a future occasion. He had no doubt in his own mind, and neither was there any doubt in the minds of the scientific gentlemen whom he had consulted, that they were diamonds, but in the meantime he preferred to describe them as pure crystalline forms of carbon. The measurement of the angle of the forms he had obtained was 1-32nd part of an inch.

Just as we were going to press we received a telegram from Mr. Mactear, in which he says that he has been working on the subject about thirteen years with varying success. He did not announce the discovery, however, until absolutely certain, and reserves details of the processes for the present. There is no difficulty in producing carbon crystals, apparently diamond, from any carbon compound whatever and by a variety of processes based on a great physical fact. Even combustion products are quite suitable. Mr. Mactear has promised us specimens for physical and chemical examination.

ON BESSEMER STEEL PLATES.

By SERGIUS KERN, M.E., St. Petersburg.

The author some time ago (Chemical News, vol. xxxviii., No. 966,) remarked that for the rolling of boiler plates out of Bessemer ingots, it is preferable to use ingots, hammered after casting. This method is employed in many works, and the reasons for doing so may be explained as follows:—

1. The plates obtained by the rolling of hammered ingots have a smooth fine surface. Flaws, scale, or excavations are seldom observed, and if they happen, this must be attributed to imperfect rolling; because an ingot which hammers well, and shows no defects during this process, is likely to roll well into plates.

2. Plates out of hammered ingots have a higher density, good structure, and are more uniform in their mechanical qualities. Such plates, even unannealed, will always stand the test in the limits of the Lloyd's regulations.

On the other hand, plates rolled directly out of unhammered ingots, show a great fluctuation in their mechanical qualities. This may be seen by the examination of the annexed tables. A want of uniformity in the results of the Table A will be observed.

AVERAGE ANALYSES.

1. *Plates Rolled out of Hammered Ingots.*

	Per cent.
Carbon	0·20
Silicon	0·02
Phosphorus	0·04
Manganese	0·32
Sulphur	0·03
Copper	none

2. *Plates Rolled out of Unhammered Ingots.*

	Per cent.
Carbon	0·24
Silicon	0·02
Phosphorus	0·03
Manganese	0·30
Sulphur	0·03
Copper	none

Table A.

Unannealed Plates, prepared out of Unhammered Ingots.

No. of Samples.	Tensile Strength Per Square Inch. (In Tons.)	Elongation. (Per Cent).
1.	25·75	31·00
2.	31·24	22·50
3.	29·17	13·25
4.	32·28	17·50
5.	29·27	25·25
6.	32·50	21·50
7.	31·48	23·50
8.	32·23	22·00
9.	32·64	25·00
10.	30·18	17·87
11.	32·50	19·50
12.	27·94	25·37

Size of specimens : length 8 inches, breadth 1·5 inches, thickness 0·625 inch.

Table B.

Unannealed Plates, prepared out of Hammered Ingots.

No. of Samples.	Tensile Strength per square inch. (In tons.)	Elongation. (Per cent.)
1.	27·82	25·50
2.	28·00	22·50
3.	27·00	22·00
4.	27·70	28·50
5.	27·56	26·25
6.	27·48	30·00
7.	27·12	25·12
8.	27·55	25·50
9.	28·00	23·50
10.	27·78	26·75
11.	27·12	25·00
12.	27·55	26·25

of specimens : as mentioned in Table A.

The hammered and unhammered ingots were rolled into plates under the same conditions, and were heated to a white non-welding heat. In most cases the ingots were finished into plates from one heat.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 18, 1879.

Mr. Warren De la Rue, President, in the Chair.

A ballot for the election of Fellows was held, Dr. Messell and Mr. Neison being appointed scrutators. The following gentlemen were declared duly elected :—G. S. Allbright, J R. Ashwell, T. Blackhouse, E. Buckney, J. Bemrose, W. J. F. Churchouse, M. Cochrane, E. J. Day, W. R. Dunstan, E. Francis, F. Hatton, J. Howard, J. J. Hummell, R. E. Holloway, W. R. Eaton Hodgkinson, T. S. Humpidge, E. Hughes, R. Jones, J. Knowles, A. Leibius, H. F. Morley, E. F. Mondy, H. Newton, J. Parette, J. W. Smith, J. Steiner, J. Snodgrass, A. Scott, G. Stallard, J. M. Wilson. The following certificates were read for the first time :—W. Macnab, W. B. Roberts, G. Salet, T. Terrell.

The Secretary then read a paper, "*On the Specific Volume of Crystallisation;*" by T. E. Thorpe and J. J. Watts. Some years ago Playfair and Joule pointed out that the volumes of certain highly hydrated salts, as for example, sodium carbonate with 10 molecules of water, also the alkaline arsenates and phosphates with 12 molecules, are equal to that of the water, considered as ice, which they respectively contain : thus the molecules of the salt seem to exist in the interstitial spaces of the ice. This law does not hold good for salts less highly hydrated. Thus, in borax, sodium pyrophosphate, and the normal aluminium sulphate the volume seems to be made up of the water considered as ice, together with that of the base as existing in the free state. Schiff has shown that members of certain classes of hydrated salts have the same specific volume. Thus all the alums have a specific volume 277, double sulphates, $M_2M''(SO_4)_2$, 207, and the vitriols, $M''SO_4 7H_2O$, 146. The authors have determined the precise relation between the specific volumes of various sulphates of copper, magnesium, zinc, nickel, cobalt, iron, and manganese, and their respective degrees of hydration. They have incorporated in the present paper some results placed at their disposal by Dr. Playfair. Details of the preparation and analysis of the various hydrates employed are given. The specific gravity was determined by weighing in benzene at 15° C. The results are contained in the following table :—

Hydrate.	0.	1.	2.	3.	4.	5.	6.	7.
$CuSO_4$ ..	44·4	54·3	67·0	80·0	—	109·1	—	—
$MgSO_4$ ..	44·8	55·6	67·0	—	—	112·4	130·8	146·8
$ZnSO_4$ ..	45·6	54·7	66.6	—	—	113·7	130·2	146 8
$NiSO_4$ ..	44·6	56·5	—	—	—	—	129·0	144·6
$CoSO_4$ ..	44·7	55·2	70·9	—	97·4	114·6	130·1	146·0
$MnSO_4$ ..	45·0	55·7	73·6	86·6	98·2	114·4	—	—
$FeSO_4$ ..	44·5	56·2	67·7	—	100·5	—	—	146 7
Means ..	44·8	55·5	68·8	83·3	98·7	112·9	130·0	146·2

From these results it appears that in the case, at least, of the so-called magnesian sulphates the volumes occupied by the several molecules of water varies with the degree of hydration. The first molecule, the "constitutional water" of Graham, occupies less bulk than any other. Its mean relative value is 10·7. The value of the second is 13·3 ; of the third, 14·5 ; of the fourth, 15·4 ; of the fifth (taking the mean of the most concordant numbers, $ZnSO_4$, $CoSO_4$ and $MnSO_4$), 15·6 ; of the sixth, 15·7 ; of the seventh, 16·2. These results accord with the fact that the different molecules of water in a hydrated salt are held with various degrees of tenacity, as shown by the different intensities of heat needed to expel them, the amount of energy required standing in some relation to the degree of condensation in the combined molecule. The authors point out the importance of estimating the amounts of heat resulting from the combination of successive molecules of water with the different sulphates. Graham has already shown that more heat was evolved in the combination of the first molecule than in that of any of the remaining molecules. In other words, that the amount of heat developed is related to the degree of condensation of the combined molecules. As the foregoing numbers express the volumes in cubic centimetres of the equivalent of the salts in grammes, it appears that equivalent quantities of these different sulphates occupy respectively the same volume in space, or, in other words, the unit volume contains the same number of molecules of the different salts.

Prof. McLeod then read a "*Note on the formation of Ozone during the Slow Oxidation of Phosphorus.*" The active substance formed during the slow oxidation of phosphorus is probably either ozone or peroxide of hydrogen. The latter substance is readily destroyed by alkalies, a solution of chromic acid, or a solution of alkaline permanganate, whilst ozone is unaffected either by a solution of sodic carbonate or by chromic acid, and appears to be only slightly attacked by alkaline permanganate. Air in which phosphorus was slowly oxidising was drawn through a U-tube 9½ inches long (filled with fragments of glass, containing in succession sodic carbonate saturated with carbonic anhydride, a mixture of potassic dichromate and sulphuric acid, and potassic permanganate previously saturated with carbonic anhydride), and then into a flask containing a solution of potassic iodide and starch. In all cases the latter solution became blue, both when the U-tube was cold and when heated to 100°. Similar results were obtained when a U-tube 12½ inches long was used, packed with small pieces of pumice and saturated with solution of sodic carbonate. The effect of heat on the gas was tried. The gas was aspirated through a narrow U-tube, which was heated to 150° and 200°. Beyond this U-tube were placed, first, a weighed U-tube packed with pumice and sulphuric acid, and, secondly, a flask with solution of potassic iodide and starch acidified with sulphuric acid. The U-tube was weighed before and after each experiment, and the blue solution titrated with decinormal sodic thiosulphate. The gas was aspirated at the rate of 1 litre per hour. The following results were obtained:—

Gas Aspirated.	Temp. of U-tube.	Increase of Sulphuric Acid Tube.	Thiosulphate Used.
4600 c.c.	cold	0·0026 grm.	2·55 c.c.
2760 ,,	100°	0·0008 ,,	1·9 ,,
4600 ,,	150°	0·0026 ,,	3·2 ,,
2760 ,,	200°	0·0006 ,,	1·8 ,,

1 c.c. of thiosulphate = 0·017 grm. of hydroxyl, which on decomposition forms 0·009 grm. of water; and as at least one half of the hydroxyl might be assumed to be decomposed, an increase of the sulphuric acid tube in the last experiment should be 0·016 grm. instead of only 0·0006. Hydroxyl combines with acids. The gas from phosphorus was exposed to the action of strong sulphuric acid for four days without losing its activity. It is extremely improbable that ozone and hydroxyl are both formed, as these substances destroy each other. The author therefore concludes that the gas obtained during the slow oxidation of phosphorus possesses the properties of ozone, and not those of hydroxyl, the only known peroxide of hydrogen.

Mr. Kingzett had listened to the paper with great interest. Up to the present time no evidence had been put on record to prove that this gas from phosphorus contained ozone, and as he had shown that certain hydrocarbons which had been supposed to produce ozone really formed hydroxyl, he had assumed, in the absence of any evidence, that hydroxyl was formed in this case. After referring to the researches of Cornu, Mr. Kingzett said that he could confirm the observation of Prof. McLeod that peroxide of hydrogen and ozone in the presence of an acid did not decompose each other.

After some remarks from the President, Prof. McLeod briefly replied.

Mr. W. H. Perkin then read a paper "*On the Analysis of Organic Bodies containing Nitrogen.*" Some years since the author wished to determine the halogens as well as the carbon and hydrogen in bodies containing nitrogen. The substance was burnt in oxygen, and the products of combustion passed over a weighed quantity of pure metallic silver. The difficulty arose as to how to get rid of the nitrous fumes: plumbic peroxide was first tried between the water absorbing apparatus and potash bulbs. This succeeded as far as the carbon was concerned, but as nitrous fumes were absorbed by the sulphuric acid the hydrogen determinations were too high. Plumbic peroxide was then placed in the combustion-tube, but great difficulty was experienced in heating it to just the proper temperature. Potassic chromate was then tried, and was found to succeed admirably: it absorbed the nitrous fumes completely, had no action on carbonic anhydride, and could be heated without fear. The author therefore recommends the use of about 6 to 7 inches of potassic chromate in the combustion of all substances containing nitrogen instead of freshly reduced copper, which is very hygroscopic and occludes hydrogen, or of silver, which requires an inconveniently high temperature. The potassic chromate should be free from an excess of alkali: a trace of bichromate is not harmful, though bichromate does not work so well as chromate. The chromate should be roughly powdered or granulated by evaporating its solution to dryness with constant stirring; or, still better, coarsely-powdered pumice saturated with solution of chromate may be used. The chromate should be kept at a scarcely dull red-heat. The author does not state how many times the chromate can be used. Chromate also absorbs sulphurous acid. It does not retain iodine vapour, but would be probably useful with substances containing chlorine or bromine.

After a few remarks from Mr. Warington the Society adjourned to January 15.

PHYSICAL SOCIETY.

Ordinary Meeting, December 13, 1879.

Prof. W. G. Adams in the Chair.

New Members:—Mr. J. H. Poynting, Mr. R. T. Glazewood, Dr. R. C. Shettle, Prof. Rowland, Mr. John Gray, D.Sc., Mr. H. R. Brook, Mr. E. B. Sargent, Mr. E. Paterson.

"*On the Graduation of the Sonometer,*" by Mr. J. H. Poynting, Trinity College. The author had endeavoured to reduce the present arbitrary readings of the Sonometer of Prof. Hughes to absolute measure by adapting the formula given in Maxwell's "Electricity" (vol. ii., chap. xiv.), to the induction of two circular coils on the same axis, but separated by a distance greater than the radii of the coil, on a third coil intermediate. By applying the formula thus obtained to the results of Prof. Hughes for different metals, he finds that either the specific resistances of metals as given in the tables are not the same as the resistances of the metals employed by Prof. Hughes, or that the induction effect of the balance or sonometer is not proportional to the conductivity of the metal.

Prof. Ayrton reminded the Society that at a former meeting he had shown mathematically that the effect was not proportional to the conductivity, but to an exponential function of the conductivity.

Mr. Chandler Roberts, F.R.S., stated that Prof. Hughes did not profess that the metals used by him to obtain his results were pure.

Prof. Adams mentioned that Prof. Hughes had shown that the effect was dependent on other conditions than the mere purity of the metal.

Dr. J. A. Fleming, St. John's College, Cambridge, exhibited and described a new form of Wheatstone Balance, designed principally for comparing the B.A. units of resistance deposited in the Cavendish Laboratory. The divided resistance is a circular platinum-iridium wire, and an arm fitted with a contact at its extremity revolves round after the manner of circular resistance-coils, thus altering the ratio of the divided resistances. The contact is a knife-edge of platinum, and it is "made" and "broken" by hand as with a key. A series of ingenious copper-mercury cups are fitted to the balance so as to permit of two coils being compared at any temperature with great exactness by the method suggested by Prof. Foster and adopted by Prof. Crystal, of Cambridge. This consists in exchanging the positions of the units on the balance, and observing the difference in the results. By Dr. Fleming's arrangement this exchange can be effected without removing the coils from heating apparatus in which they are placed, or otherwise altering their conditions. The mercury contact-cups and the heating-cans were also improved by Dr. Fleming for the purpose of facilitating accuracy of results.

Prof. Perry described a Dispersion Photometer devised by himself and Prof. Ayrton for the purpose of comparing intense lights, such as the electric, with a standard candle without necessitating much room in order to put the stronger light at a distance from the screen proper to give an illumination equal to that of the candle. To reduce the distance of the stronger light from the screen, the authors had inserted a lens in the track of the beam, so as to disperse the beam to a degree which could be determined by an easy formula. Thus, by artificially diluting the powerful beam they could compare it with the feebler beam from the standard light in a shorter space. For an electric light of 6400 candles only 8 feet need be required by the new plan instead of 80 feet by the unassisted method.

Dr. **John Hopkinson**, F.R.S., stated that he had actually used the same method for some months past in his electric light experiments, and recommended a plano-convex lens as the best to use, and suggested that the focal length should be calculated. He thought that the error due to absorption could easily be obviated.

Prof. **Ayrton** then described a method by which Prof. Perry and he had determined the value of g, or the coefficient of gravity, at the Imperial Engineering College, Tokio, Japan, by means of pendulums. Their result is 980·06; and calculation from the position of the place makes it 979·8.

An Improved Form of Spherometer, designed by Mr. W. Goolden, and made by Mr. Adam Hilgar was exhibited to the meeting. The frame is of aluminium, combining lightness and rigidity; the legs and screws of hard steel. The screw carries a drum divided into 1000 parts, and the instrument gives a reading to the $\frac{1}{100000}$ of an inch by the usual method of touch. Increased sensitiveness is got by employing a galvanometer to indicate the contact of the middle pointer with the surface. By this means it is made correct to $\frac{1}{500000}$ inch. A smaller form of the instrument, correct to $\frac{1}{50000}$ inch, was also shown.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, November 18, 1879.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., President, in the Chair.

The **President** noticed the lamented death, since the last meeting, of Prof. James Clerk-Maxwell, an event which, having occurred in the prime of his life and in the midst of his usefulness and his splendid researches, was felt most severely by the Society and the whole scientific world.

"*Recording Sunshine*," by **David Winstanley**, F.R.A.S. So far as I have seen there is in use at present but one form of apparatus which effects an automatic registration of the duration and the times of sunshine, and that is the instrument of Campbell, in which a sphere of glass is so disposed as to burn a piece of wood or paper by the concentration of his rays when the sun may chance to shine. During the past few years I have devoted some attention to this matter and devised a number of appliances having the same object for their end but differing materially both in their construction and in the manner of their use from the apparatus I have named.

One of these, with your permission, I will now describe.

It is an arrangement which places a lead pencil on a sheet of paper and writes down therewith when and for how long the sunshine lasts.

It consists essentially of a differential thermometer with a long horizontal stem, in which latter is contained throughout the greater portion of its length some fluid intended to operate by its weight. This thermometer is attached to a scale beam or some equivalent device which also carries the pencil by means of which the record shall be made.

The whole is so arranged that in its normal state it rests gently—upon that side to which the pencil is *not* attached—on an embankment provided for that end.

Close beneath the pencil point a disc of metal rotated at the proper speed carries a paper dial whereon marks and figures are engraved corresponding with the hours at which the sun may shine.

When using this instrument I have it enclosed within a box which permits one bulb only of the thermometer—that most distant from the clock—to be affected by the radiance of the sun, which when it shines expands the air contained therein, forces the fluid along the tube, and by altering the equilibrium of the beam brings some portion of its weight to bear upon the pencil point, and so the record is commenced.

When the sun becomes obscured, the air expanded by his rays contracts, the fluid in the tube returns, the normal equilibrium is restored, and the pencil ceases to produce its mark.

In the instance of the instrument I use the stem of the thermometer is 18 inches long and the eighth of an inch or thereabouts in bore.

Mercury in consideration of its weight is the fluid I employ, and in conjunction with it some sulphuric acid is enclosed, because of the mobility which is thereby gained. I am aware that in these circumstances mercuric sulphate is very slowly formed, but after two years' lapse of time no inconvenience has been caused thereby and the mobility of the mercury remains.

The bulbs of the thermometer are 2 inches in diameter or thereabouts, and that they may be more rapidly affected the glass thereof is thin. Both are blacked, and the one intended to receive the radiance of the sun projects above the box in which the apparatus is contained into a dome of glass.

"*On some Notices in Classical Authors of the Action of Sunlight on Purple Dye*," by **James Bottomley**, D.Sc., F.C.S.

"*On the Origin of the Word Chemistry*," by **Carl Schorlemmer**, F.R.S. Chemistry as a science is first mentioned[*] by Julius Maternus Firmicus, a native of Sicily, and procurator under Constantine the Great. He wrote at about 336 a work on Astrology, which has been preserved only in a defective state, and is commonly known by the name of *Mathesis*.

In this work he states that by observing the position of the moon, in respect to certain heavenly bodies or constellations, at the hour when a child is born, its future inclinations can be predicted. He continues: *Et si fuerit haec domus Mercurii, Astronomiam. Si Veneris, cantilenas et laetitiam. Si Martis, opus armorum et instrumentorum. Si Jovis, divinum cultum et scientiam in lege. Si Saturni, scientiam alchimiae. Si Solis, providentiam in quadripedibus. Si in Cancero, domus sua, scientiam dabit omnium quae exeunt de aqua.*[†]

Other editions of this work have also *scientia alchimiae*,[‡] but Vossius informs us that in the manuscripts it is *chimiæ*.[§] He says: *Alchimiæ scientiam nominat Firmicus, lib. III., cap. XV. Ita quidem editum ab Aldo, sed in chirographis est chimiæ.*

Athanasius Kircher also states that the manuscript in the library of the Vatican has *chymiæ* and not *Alchymiæ*.[||]

Firmicus does not give any explanation of this term. However, another writer, who probably lived at the same time, if not earlier, explains it. Zosimus, the Panopolite, according to Georgios Synkellos, a writer of the ninth century, states that *χημεια* (or *χυμεια*, as some manuscripts have) meant the art of making gold or silver.[¶]

The curious passage in which this word occurs is the following:—

"The sacred Scriptures inform us that there exists a tribe of genii, who make use of women. Hermes mentions this circumstance in his Physics; and almost every writing (λογος), whether sacred (φανερος) or apocryphal, states the same thing. The ancient and divine Scriptures inform us that the angels, captivated by women, taught them all the operations of nature. Offence being taken at this, they remained out of heaven, because they had taught mankind all manner of evil, and things which could

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[*] Kopp, "Beiträge zur Geschichte de Chemie," 43.

[†] Julius Firmicus de nativitatibus; Ed. Simon Bivilaqua, Venice, 1497.

[‡] Ed. Aldus Manutius, Venice, 1499; Ed. Nicolaus Brucknerus, Bâle, 1533.

[§] Etymologicon linguæ latinæ, Amsterdam, 1695.

[||] Kopp, *loc. cit.*, 9.

[¶] Thomson's "History of Chemistry," 5.

not be advantageous to their souls. The Scriptures inform us that the giants sprang from their embraces. *Chema* is the first of their traditions respecting these arts. The book itself they called *Chema*; hence the art is called *Chemia*."

It is not difficult to trace the origin of this myth. We find it first in Genesis, chap vi.: "And it came to pass, when men began to multiply on the face of the earth, and daughters were born unto them, that the sons of God saw the daughters of men that they were fair, and they took them wives of all which they chose."

"There were giants in the earth in those days; and also after that, when the sons of God came in unto the daughters of men, and they bare children to them, the same became mighty men, which were of old, men of renown."

Alluding to this later writers state that the fallen angels taught women all the secrets of nature.[*] That one of these is the art of making gold and silver is, however, first mentioned by Zosimus. Other Greek writers use the word Chemia or Chymia in the same sense; in print we find it first in the Lexicon of Suidas, who lived in the eleventh century, and defines *χημεια* as "the preparation of gold and silver."

All the earlier Greek writers who mention this word were in close connection with the university of Alexandria; from this it has been inferred that the artificial preparation of the noble metals was first attempted in Egypt.

That country was conquered by the Arabians in 640. Here they made undoubtedly their first acquaintance with chemical science; they prefixed their article to the Greek name, and thus introduced the terms, Alchemy, Alchimy, or Alchymy.

The origin and meaning of these terms have often been discussed. Plutarch states that the old name of Egypt was *χημια*; that it was so called on account of its black soil, and that the same word designated the black of the eye. From this the conclusion has been drawn that chemistry originally meant the science of Egypt, or the black of the eye being the symbol of darkness and mystery, chemistry was the secret or black art. But alchemy has never been called the black art, a name which was exclusively reserved for magic or necromancy.

It has also been stated that the name was derived from the Arabic *kema*, to hide, while others have maintained that the founder of our science was Cham or Ham, the son of Noah, or an Egyptian king with the name of Chemmis. It has further been suggested that the name of the science was derived from *χέω*, to melt; or from *χυμος*, juice or liquid.

To this it has been objected that the original spelling was *χημεια* and not *χυμεια*, which, although Hermann Kopp, the great historian of chemistry, inclines to this view, has not yet been proved satisfactorily. Humboldt believes that the latter word got into some manuscripts by a mistake of the transcriber, and continues: "Alchimy commenced with the metals and their oxides, and not with the juices of plants." This objection, however, cannot be maintained at all, because vegetable juices, or, at least, substances designated by their names, are mentioned by the older alchemists as the most potent substance by which transmutations could be effected.[†]

Some time ago my friend Prof. Theodores called my attention to an interesting paper on this subject, published by Prof. Gildemeister,[‡] in which he maintains the derivation of the word chemistry from *χυμος*. According to him *kîmiyâ* in Arabic does not originally have an abstract meaning, and is the name, not of a science, but of a body by which, or rather by a substance obtained from which, the transmutation of metals is effected; it is synonymous with *iksîr*. Alchemy, as a science, was called: The preparation of *kîmiyâ* or *iksîr*, also the science of the preparation of *kîmiyâ*, or, more shortly, science of *kîmiyâ*. In the Arabic Lexicon (Qâmûs) *al-iksîr* is explained by *al-kîmiyâ*, and the latter again by the former, or by any medium which, applied to a metal, transports it into the sphere of the sun or the moon, *i.e.*, converts it into gold or silver.

Even to this day the word is used in the concrete sense; Kotschy[*] relates that the pasha of Nicosia talked much of flowers, chiefly *kimia*, a plant having the property of converting metals into gold.

The later writers, however, called the science shortly *al-kimiyâ*, and retained the term *al-idsir* (elixir) for the transmuting medium or the philosopher's stone. This latter word is identical with *ξήριον*, as the writers of the Alexandrine school called the philosopher's stone,[†] while the same name was employed by the physicians for a healing powder, used for sprinkling over wounds, *i.e.*, a desiccative powder (from *ξηρος*, dry).[‡]

Now the correlate to dry is moist or liquid, *χυμος*, and from this is derived *χυμεια*, a moist substance corresponding to *λιθεια*, a material formed of *λιθος*, or *κεραμεια*, the occupation with *κέραμος*.

Ibn Khaldûn, who lived in the 14th century, says that from the philosopher's stone a liquid or a powder might be prepared, called *iksîr*, which, when thrown on molten copper converted it into silver, and molten silver into gold. In opposition to its etymology the word is here used for a liquid, because at that time *kîmiyâ* no longer meant the transmuting substance, but the science of transmutation, and explains why to-day we may understand by elixir a liquid.

We also find that the philosopher's stone is often called the red tincture, from *tinguo*, to moisten.

It appears, therefore, very probable that the name of our science is derived from *χυμος*, and the proper spelling would therefore be *Chymistry*, as the *Times* newspaper for a long time insisted upon. As, however, this derivation has not yet been proved quite satisfactorily, the time-honoured term *Chemistry* will remain in use, and I think be retained even if it should be shown that *χυμεια* was the original spelling.

Ordinary Meeting, December 2, 1879.

Dr. R. Angus Smith, F.R.S., &c., Vice-President, in the Chair.

"*On a Peculiar Feature in the Water of the Well in Carisbrooke Castle, Isle of Wight*," by Harry Grimshaw, F.C.S. The sample of the above water was taken by me on April 19, 1878, but was never opened or interfered with in any way until the following September. The water when taken was very bright and clear, and free from sediment of any description. It was totally devoid of odour, and was of a fresh and sparkling taste. The local features of the well from which the water derives its origin are as follows:—Carisbrooke Castle stands on a small isolated chalk hill, 239 feet above the level of the sea. The well is under cover in the "well house," and according to Jenkinson is 240 feet in depth. It is perfectly free, even at the surface of the water, from carbonic acid gas, or in fact of more than traces of any other gas than atmospheric air, as a candle floating on the water burns freely.

The bottle containing the water was opened on the 12th of September, and on doing so a very strong odour of sulphuretted hydrogen was perceived, and on testing with lead-paper an equally strong reaction for that gas was obtained. There was also apparent a slight sediment of a white colour not originally seen in the water. The reaction to litmus was perfectly neutral. The analytical data obtained, which were all that was possible from the quantity of water at command, were as follows:—

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[*] Kopp, *loc. cit.*, 4.

[†] Kopp, *loc. cit.*, 76.

[‡] *Zeitsch. Deutsch. Morgenland. Ges.*, xxx., 634.

[*] Petermann, *Geog Mitth.*, viii., 294.

[†] Kopp, *loc. cit.*, 209.

[‡] Zosimus calls the substance by which copper is tinged yellow or converted into brass, *το δια της θουθιας ξηριον*, a powder prepared by means of tutia; now tutia (zinc oxide) is still to-day used in medicine as a desiccative.

Total solid matter ..	42·00	grs. per gal. (consisting of)
Mineral matter	22·40	,, ,, and
Volatile matter	19·60	,, ,,
Total hardness	12·30	,, ,,
Magnesia hardness ..	1·70	,, ,,
Chlorine	4·50	,, ,,

The residue on heating blackened very much, and emitted a very strong unpleasant odour like burning animal matter.

The peculiarity of this water is of course the production of sulphuretted hydrogen, on standing for some time (in this case for five months) out of contact with the atmosphere. On leaving a small portion of the water in the bottle again corked up for some time the presence of sulphuretted hydrogen was not exhibited. This production of sulphuretted hydrogen proceeds undoubtedly from the reduction of the sulphates contained in the water by the excess of organic matter, and it is not unique in this instance, although it is not a fact of very common occurrence. I regret very much not having been able to bring back a sample large enough to admit of a determination of the albuminoid ammonia, and the nitrates and nitrites, as the quantity of these substances in a water of such a description would have been a very interesting item in the case, as touching on a point of great importance in pronouncing an opinion on the quality of a water. It is very possible and even probable that some chemists, given to judging for and against a water chiefly by indications of a single description, to the comparative neglect of many other analytical results, say by the amount of albuminoid ammonia, might actually fail to condemn a water such as the above; for many chemists appear to consider the ignition of the solid residue a comparatively unnecessary detail; and supposing even that the nitrates had been determined in this water, there are eminent chemists who have considered the presence of nitrates in deep well waters, in the chalk especially, as comparatively innoxious. The Carisbrooke well, as I have said, is in the chalky strata, and is 240 feet deep, and whether it contains nitrates or not, is, in my opinion, on the results above detailed, a most unfit water for potable purposes, and my reason for bringing the analysis of this water before the Society was to draw attention to the tendency often exhibited to draw the chief inferences of the quality of drinking waters from what may be called isolated reactions, without obtaining, or at all events without giving weight to, other indications, chemical and physical, which they exhibit.

Captain Abney, R.E., F.R.S., exhibited his photographs of the ultra-red portions of the solar spectrum, and first of all showed that the light transmitted by ordinary bromide of silver was of an orange tint, showing absorption in the lowest end of the spectrum. He then went on to explain how he had tried to load the molecules comprising this bromide of silver by means of gum resins, and that he had thus been enabled to photograph slightly beyond the lowest limit of the visible spectrum. Further researches proved that bromide of silver could be prepared in two molecular states, one that already shown, and the other in which absorption takes place in the red as well as in the blue. This was found sensitive to every radiation. He pointed out that the blue form of the silver bromide could be converted into the red form by simple friction, and that after friction it was insensitive to the ultra-red radiation.

Prof. Roscoe here exhibited the different preparations of gold in minute division made by Faraday himself, some of which transmitted blue light and others red, showing that at all events two cases of molecular condition exist in the case of metallic gold.

Captain Abney then threw upon the screen photographs of the prismatic spectrum, in one of which the lowest limit of the prismatic spectrum was reached. He demonstrated this on the black board by setting up as ordinates the wave-lengths of the various portions of the photographs as obtained from the photographs of the diffraction spectrum.

He then exhibited various photographs of the ultra-red portion of the diffraction spectrum, extending from 7600 to about 11,000. He stated that the photographs from which he was making his final map were taken on double the scale, with twice the amount of dispersion.

He then showed various prismatic spectra, exhibiting different states of atmospheric absorption, in one of which Piazzi Smyth's rain-band was markedly visible.

After a short discussion, Captain Abney exhibited some photographs of the spectrum in natural colours.

NOTICES OF BOOKS.

Auxiliary Tables for Instruction in Chemical Analysis. (*Hülf's Tabellen für den Chemisch-analytischen Unterricht.*) Edited by Otto Wallach, with the co-operation of Aug. Kékulé, A. Bernstein, H. Klinger, and C. Wachendorff. Bonn: E. Weber.

The compiler of this little work fully recognises as not unfounded the prepossessions now widely entertained against the tabular form of instruction. He aims, however, at placing in the hands of the student not—as is too generally the case in tables—a mere routine to be followed, but a key to the understanding and intelligent execution of analytical methods. From the very outset the pupil is led to a consciousness of the reasons for selecting any particular procedure in preference to others. These objects are, we think, as far as possible within a space so limited, satisfactorily attained. The author recommends a close comparative examination of his Tables I. and X. The former of these contains preliminary remarks on a right understanding of the analytical process and on the use of the tables. The latter, No. X., is devoted to an examination of the solution containing metals of the "ammonium sulphide" group in presence of phosphoric or oxalic acid. In both these tables we find attention called to points often slurred over. Thus, as regards the preliminary step of dissolving the unknown body placed in the hands of the operator, be it a single compound or a mixture, we have met elsewhere with the direction to treat with water, or hydrochloric acid, or nitric acid, or aqua regia. Herr Wallach, on the contrary, advises these solvents to be used in succession *in this order* as far as needful, and supplies indications in case the substance, wholly or in part, does not dissolve in any of them. He also speaks of the examination of the physical properties of the sample, and of its behaviour in the dry way, not as mere tentatives which may be omitted at pleasure, but as rightly preceding the investigation in the wet way. At the foot of the table we find the advice "above all things to perform none of the operations without having a clear understanding of the reason why." The table for the examination of substances in water and acids, and of those where the elements present are masked by organic matter, strikes us as very valuable.

The work being intended for beginners only, the rarer elements are not included in its plan, and the author does not count on rendering the oral advice and the supervision of the teacher unnecessary.

In fine, we may safely say that numerous as are the manuals, handbooks, and sets of analytical tables now in existence, the work before us will be found useful in the laboratories of our colleges, and is not to be set aside as an "Ilias post Homerum." There is no reference to examinations and the means of passing them, the author's object being simply to train sound chemists capable of doing good work.

The Use of Borax for the Preservation of Meat.—E. de Cyon and G. Le Bon.—The *former author recommends the use of borax, and the latter pronounces it injurious.—Biedermann's Centralblatt.*

CORRESPONDENCE.

FLUID MEDIUM FOR IMMERSION LENSES.

To the Editor of the Chemical News.

Sir,—Referring to my former letter on the subject of suitable fluids for use with microscopic objectives on the homogenous immersion principle (Chemical News, vol. xl., p. 213), I beg to call attention to a note appended to the recently-published paper read before the Royal Microscopical Society,* June 11, 1879, by Professor E. Abbe, of Jena.

"Microscopists who are connected with chemical matters are kindly requested to promote the homogeneous immersion method by looking out for such less known liquids as afford some hope of being useful for the purpose, and I shall be glad to investigate every sample which may be sent to me for trial. A few drops only is quite sufficient for exact measurement by means of the refractometer of the refractive and dispersive indices."—I am, &c.,

W. T. Suffolk.

Stettin Lodge, St. Faith's Road,
Lower Norwood, S.E.,
December 15, 1879.

ALUMINIUM PLATE AS A SUPPORT IN BLOWPIPE WORK.†

To the Editor of the Chemical News.

Sir,—Critics no doubt differ in estimating the amount of acknowledgment due to inventors, but while cordially concurring with all you say regarding the merits of M. Landauer's lately published little work on blowpipe analysis, I would ask you, as one of our most distinguished discoverers, if you think it altogether fair to insert detailed descriptions of a man's invention in *thirteen pages* of a small book, as M. Landauer's English editors have made him do with regard to the new reactions on aluminium plate; to refer—not in the text, but in a note—to the inventor as only having "recommended" the novelty; and, finally, without further mention of the inventor's name, to refer thus to the matter in the index—"Hutchings: Aluminium plate reactions"? M. Landauer writes to me on the subject thus:—"I have, however, not stuck strictly to this principle [of not naming authors], but made exceptions with regard to the most important improvements. Among those is your application of Al plate." Having no copy at hand I cannot speak to the wording of the citation, but most likely it will be in harmony with the source used, viz., Hutchings's article, which said:—"By far the best support is the above-named Al plate, first used by Major Ross, and described in his work, 'Pyrology.'" But Hutchings also said, either in the *Mining Journal* or Chemical News, that "Al plate raised this entire branch of blowpipe analysis to a higher standard."—I am, &c.,

W. A. Ross.

London, W., December 14, 1879.

P.S.—The use of gold, by the way, for detecting nickel is not a novelty, but mentioned in Plattner's 4th edition.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Biedermann's Central-blatt für Agrikultur-Chemie.
November, 1879.

Application of a Natural Product as Manure.—Prof. F. Ullick.—The substances concerned are basalt and the tufas and wackés found in its vicinity. The analysis of such a wacké yielded potash 0·68 and phosphoric acid 0·62. The author recommends the same material for absorbing crude potassium salts for application on the land.

Manurial Experiments for Determining the Requirements of Arable Soils.—Baron Dael von Koeth.—The results of experiments carried on for thirteen years near Maintz, on a calcareous soil. Reverted phosphates gave better crops than soluble phosphate employed alone. Gypsum was not appreciably useful.

Influence of Various Manures on the Combustibility of Tobacco.—Gaetano Cantoni.—The Stassfurt salts, night-soil, and all manures rich in chlorine injure the burning-power of the leaf.

Studies on the Digestive Process in Sheep.—Dr. E. Wildt.

Researches on the Digestion of Food in Horses under the Influence of Increased Work.—Prof. E. v Wolff, Prof. W. v. Funke, Dr. C. Kreuzhage, and Dr. O. Kellner.

Digestion of Potatoes and Flesh-Meal in Pigs.—Prof. E. v. Wolff and Prof. W. v. Funke.

Chemical Studies on the Activity of Bees.—Dr. E. Erlenmeyer and Dr. A. v. Planta-Reichenau.—The authors conclude that wax is chiefly formed by the bees from sugar. Sugar occurs in honey chiefly as glucose, though cane-sugar is also present. Both the pollen of flowers and the saliva of the bee are powerful inverting agents.

Growth of Vines from Seed.—Dr. A. Blankenhorn.—The author maintains that the constitution of European vines is exhausted, owing to their continued propagation by layers and cuttings. He recommends propagation by seed as a defence against the *Phylloxera*.

Determination of the Value of Bone-Black.—Dr. Reinecke and G. F. Meyer.—The decolourising power of bone-black is inversely as its specific gravity.

Determination of Value of Wines.—MM. Houdart and Petit.—The authors determine the specific gravity at 15°, the alcohol at the same temperature, and the weight of the dry extract per litre.

Determination of Glycerin in Wines.—Prof. C. Neubauer and Dr. E. Borgmann.—The authors, using Pasteur's method as modified by Reichardt, found in genuine wines 0·978 to 1·667 per cent of glycerin.

Detection of Adulterations in Butter.—The methods for the detection of spurious fats are arranged under three heads: (1) microscopic examination, (2) determination of the specific gravity, and (3) separation of the fatty acids.

Presence of Sulphuric Acid in Milk.—Dr. G. Musso and F. Schmidt.—The authors have invariably detected sulphuric acid in normal milk.

Les Mondes, Revue Hebdomadaire des Sciences.
November 27, 1879.

Mechanical Equivalent of Heat.—Prof. von Waltenhofen.—The results obtained agree in a satisfactory manner with Joule's equivalent.

Laws of the Expansion of Metals.—M. de Heen.—The author has shown some time ago that in the metals of one and the same natural group the product of the coefficient of expansion by the absolute temperature of fusion is a constant number. He has recently enquired how the coefficient of the expansion of water varies with the nature and the quality (quantity?) of the substances held in solution, and he finds that there is also a constant relation between the coefficient of expansion of organic liquids belonging to one and the same homologous series and the boiling-point. The product of one of these magnitudes by the other is constant.

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* *Journal Royal Microscopical Society*, December, 1879, p. 823.

† The title used by Mr. Hutchins in Chemical News, vol. xxxvi., p. 208, 217.

Chemiker Zeitung.
No. 49, 1879.

Manufacture of Permanent White, and Utilisation of the By-products.—The commencement of a lengthy memoir.

Manufacture of Magenta by Coupier's Process.—Dr. O. Witt.—The only manufacturers employing this method are Coupier himself and the firm of Meister, Lucius, and Brüning.

New Apparatus for the Determination of Urea.—G. Buts.—Requires the accompanying figure.—*Rép. Pharm.*, vii., 503.

MISCELLANEOUS.

University of London.—The following are lists of the candidates who have passed the recent Second B.A. and B.Sc. Examinations for honours:—

(B.A. and B.Sc. conjointly.)

Mathematics—First Class: R. S. Heath, B.Sc. (Scholarship), Trinity College, Cambridge; A. E. Steinthal, B.A., Owens College and Trinity College, Cambridge.

Mental and Moral Science—First Class: D. S. MacColl, B.A. (Scholarship), University College; W. H. Findlay, B.A., Merton College, Oxford; J. A. Newbold, B.A., Owens College. Third Class: M. A. Power, B.A., Stonyhurst College; D. C. Ross, B.A., University College; T. F. Kerry, B.A., Regent's Park and University Colleges; B. B. Le Tall, B.A., Owens College; W. A. Todhunter, B.A., private study.

(B.Sc. only.)

Chemistry—Second Class: E. H. Rennie, M.A., Sydney, St. Mary's Hospital and private study.

Experimental Physics—First Class: S. L. Hart, (Scholarship) St. John's College, Cambridge; S. G. H. Barfield,* private study. Second Class: J. W. W. Waghorn, private study; E. Hopkinson, Emmanuel, Cambridge, and Owens Colleges.

Botany—First Class: G. B. Hoffmeister, Gonville and Caius College, Cambridge. Third Class: J. G. Ridsdale, Guy's Hospital and private study.

Zoology—First Class: W. D. Halliburton (Scholarship), University College. Second Class: S. J. Hickson, Downing College, Cambridge; W. Overend, University College and St. Bartholomew's Hospital. Third Class: J. J. Fletcher, B.A., Sydney, Royal School of Mines and University College.

Physiology—Second Class: W. D. Halliburton, University College; J. G. Ridsdale, Guy's Hospital and private study.

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* Obtained the number of marks qualifying for the Scholarship.

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